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Interactive E-learning
Application





MAIN BOOK



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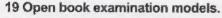
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From: Salts.

Lesson 3

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2 Guiding models of the Ministry of Education.

Examination of the Ministry of Education 2021.





UNIT

Chemistry is the Central Science

Chapter One

Chemistry and Measurement.

Chapter Two

Chemistry and Nanotechnology.

Exam model on the unit



Learning outcomes of unit one

- ▶ By the end of this unit, the student will be able to :
 - · Identify what is chemistry.
- Explain the relationship between chemistry and the other branches of science.
- Identify the nature of measurement and its importance.
- · Mention the tools and apparatuses used in chemistry labs.
- Use practical tools which are suitable for the curriculum with accuracy and efficiency.
- Understand the concept of Nanotechnology.
- Specify some of the applications of the chemistry of Nanotechnology.
- · Conclude that some of the applications of Nanotechnology have useful effects, while others are harmful.
- The included life topic: Science, technology and the society.



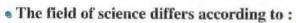
Chemistry and Measurement



Since the beginning of mankind, he is searching and exploring the surrounding universe to understand its phenomena, explain it and even to control it. All of what man had reached

Science which is an organized structure of knowledge that includes facts, concepts, principles, laws, scientific theories and an organized method in research and investigation.

from his researches is coordinated in a structure called



- The different phenomena under study.
- The used methods in research.
- The used tools.
- Chemistry is one of the natural sciences.

Chemistry is the science that is interested in studying the composition and properties of matter, the changes that occur to it, the reactions of different



- Medicine and medicaments.

Importance of chemistry in ancient civilizations

- The ancient Egyptians used some chemicals in mummification.
- Since the ancient civilizations, chemistry has been related to:
 - Some technical industries, such as:

- Metals and mining.

- Tanning. Dyeing of clothes.
- · Glass industry. · Colors industry.
- Nowadays, chemistry has very essential roles in all aspects of life.

Chemistry has been divided into branches like:

1 Physical chemistry.

Biochemistry.

Organic chemistry.

Analytical chemistry.

1 Thermochemistry.

1 Nuclear chemistry.

1 Electrochemistry.

1 Environmental chemistry ... and other else.

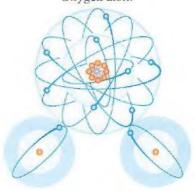
The fields of chemistry studies

The science of chemistry is interested in:

- Studying the atomic and molecular structure of matter (the bonds within it) to identify the properties of the different substances qualitatively and quantitatively.
- Understanding and controlling the chemical reactions and their conditions.
- Obtaining new beneficial products that can be used in medicine, agriculture, engineering and industry.
- Treating some environmental problems, such as: Pollution of (water - air - soil), the shortage of water and energy crisis.



Oxygen atom



Hydrogen atom

Hydrogen atom

Molecular structure of water molecule

Chemistry is the central science

Chemistry is considered the center of most of other sciences, because it is essential to understand the other sciences.

Examples

🚺 Biology.

2 Physics.

8 Medicine and pharmacy.

Agriculture.

Future sciences.

Chemistry and Biology

Biology is interested in studying the living organisms.

- Chemistry is interested in studying the chemical reactions that occur inside the living organisms (e.g. digestion, respiration and photosynthesis).
- Chemistry is combined with biology in a science called Biochemistry which is interested in studying the chemical composition of the components of the cell in various organisms (e.g. carbohydrates, fats, proteins and nucleic acids).



Chemistry contributes in identifying the components of the human body

2 Chemistry and Physics

Physics is interested in :

- Studying all about the properties of matter like its movement, energy, mass and velocity.
- Inventing new more accurate methods for measurement.
- Trying to understand the natural phenomena and the forces affecting them.
- Chemistry is combined with physics in a science called
 Of a science called
 Physical chemistry which is interested in studying the properties
 and the structure of matter as well as the particles that form this matter.



The magnetic properties of the iron filings

3 Chemistry, Medicine and Pharmacy

Medicines are chemical compounds that have therapeutic properties and can be extracted from natural sources or prepared in laboratories.

 Chemistry plays an important role in each of medicine and pharmacy fields, by knowing the nature and the functions of the hormones and the enzymes, and explaining the role of medicine in treating the hormonal and enzymatic disorders.



Some cough medicines are extracted from Guava leaves

4 Chemistry and Agriculture

Chemistry helps in agriculture through:

- Selecting the suitable soil for planting a certain crop through the chemical analysis which determines the proportions of the soil components and their sufficiency for this plant or crop.
- Increasing the productivity of crops, as chemistry can prepare the suitable fertilizers for each crop.
- Producing the insecticides to get rid of the agricultural pests.





Fertilizers increase the fertility of the soil

5 Chemistry and the Future

We can **discover** and **form** some substances with extraordinary properties through using **Nanochemistry** which is the science that is interested in discovering and forming new substances with extraordinary properties that may be used for improving various fields to provide numerous human needs.

* As we will study in the next chapter, these substances may be used for improving various fields like engineering, communications, medicine, environment, transportation and provide numerous human needs.

Worked Example

The opposite figure represents the movement of the ions with and against the gravity of earth through a root hair of a plant, this represents a certain kind of integration of

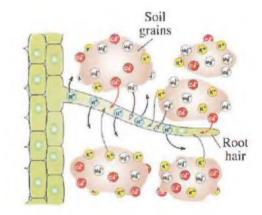
chemistry,

- (a) medicine and agriculture.
- (b) biology and medicine.
- (c) physics and biology.
- d agriculture and physics.

Idea of answering:

- : The movement of the ions through a root hair of a plant includes the integration of chemistry and biology.
- .. The choices (a) and (d) are excluded.
- : Physics is the science which studies the forces such as the gravity.
- :. The figure illustrates the integration of chemistry, physics and biology.

Answer: The correct choice is (c)



Measurement in Chemistry

* The advancement of the scientific, industrial, technological and economical fields is the result of the correct and accurate use of **Measurement principles**.

Measurement is the comparison of an unknown quantity with another known quantity of the same kind in order to know the number of times which the unknown includes the known quantity.

Any measuring process must include two main points, which are:

Mass of one pin 0.5 g	
Mass of unknown number of pins 90 g	
Number of pi	$ns = \frac{90}{0.5} = 180 \text{ pins}$

The concept of measurement

- 1 Numerical value: Describes the measured quantity or property.
- 2 Suitable measuring unit: Indicates a certain standard to which the measured quantity is being referred (in the international measurement system SI), and it is defined as a certain portion (definite magnitude) of a certain physical amount (quantity) used as an indicator to measure an actual portion of this amount (quantity).



A result of a measuring process

Test Yourself

Which of the following expresses a quantitative measurement?

- (a) Aluminum bar is longer than copper bar.
- (b) The first solution is more concentrated than the second solution.
- © The colour of the first solution is blue.
- (d) The temperature of the second solution is 60°C

Idea of answering:

Any quantitative measurement includes a numerical value and a measuring unit.

Answer: The correct choice is

The importance of measurement in chemistry

- * Measurement provides us with the necessary information and quantitative data to help us take the proper decisions and the required measures in the different aspects of life, such as:
 - Environment.

Nutrition.

Health.

Agriculture.

Industry.

The importance of measurement is manifested in:

- Giving information about the type and the concentration of the elements forming the substances.
- Monitoring and health protection.
- 3 Diagnosis and suggesting the suitable therapy in case of defects (diseases).

Giving information about the type and the concentration of the elements forming the substances

* Nutrition facts labels are very important for the consumer, as they enable him to be aware of the types and the concentrations of the components.

Application

Measuring the concentrations of the ions which form the salts in mineral water.

- * By analyzing the data on the labels of each of the two bottles, the following can be concluded:
 - It is much better for the person who follows low salt diet to use bottle (A), where it contains lower amounts of ions forming the salts.
 - The person who consumes 1.5 L of water of bottle (B) during one day will receive an amount of calcium ions Ca2+ equals $70 \times 1.5 = 105 \text{ mg}$



Components	Concentration in bottle (A) (mg/L)	Concentration in bottle (B) (mg/L)	
Na ⁺	25.5	120	
K ⁺	2.8	8	
Mg ²⁺	8.7	40	
Ca ²⁺	12	70	
Cl ⁻	14.2	220	
HCO ₃	103.7	335	
SO ₄ ²⁻	41.7	20	

2 Monitoring and health protection

- * Environmental safety and health protection both require monitoring each of the following:
 - The validity of drinking water for human use.
 - The purity of air.
 - Safety of food and agricultural products.



Health protection requires monitoring the validity of water for human use

Application \

Monitoring the validity of drinking water for human use according to international standards.

* The table shows the international standards to evaluate the validity of drinking water, and according to these standards, the bottles (A) and (B) are both valid for human use, as the concentrations of the ions in both of them are within the safety range.

The international standards of the concentrations of the ions in water (mg/L)	Concentration in bottle (A) (mg/L)	Concentration in bottle (B) (mg/L)
Na ⁺ < 150	25.5	120
K ⁺ < 12	2.8	8
$Mg^{2+} < 50$	8.7	40
Ca ²⁺ < 300	12	70
Cl ⁻ (200:250)	214	220
$SO_4^{2-} < 250$	41.7	20

Diagnosis and suggesting the suitable therapy for diseases

Medical analyses reports indicate the health status of the patients by comparing
their medical analysis values with the values of healthy persons which are known as
The reference value which is the normal range of the lowest and the highest values
obtained from normal healthy people.

Application

- * Using the opposite medical analysis report to clarify the following:
 - The amount of glucose in this person's blood is within normal range.
 - The level of uric acid is abnormal, it is higher than the normal reference value range.
 - This indicates the presence of a certain malfunction in this person's body that needs to be treated.

Type of analysis	Value of analysis (mg/dL)	Reference value (mg/dL)	
Glucose	70	70 - 110	
Uric acid	9.2	3.6 - 8.3	



Test Vourself

- (b) uric acid and cholesterol.
- c) cholesterol and triglycerides.
- d blood glucose and cholesterol.

Idea of answering:

- ... The amount of blood glucose
- : The choices and are excluded.
- The level of uric acid is
- : The choice is excluded.

Answer: The correct choice is ©

Measuring tools in the chemistry laboratory.

- Chemical experiments are performed in the chemistry laboratory, because they require:
 - Safety precautions.
 - A source of water.
 - A source of heat (e.g. Bunsen flame).
 - Cupboards and shelves to store chemicals, tools and various apparatuses, among them are:
 - The sensitive balance.

Beakers.

- Graduated cylinders.
- 🗿 Flasks.

Burette.

- 6 Pipette.
- Tools of measuring the pH value.
- It is necessary to know how you can use each of these tools and apparatuses.



Reference value

0.7:1.1

 $0.035 \cdot 0.07$

1.2:2

0.35:1.57

Result

1.09

0.06

2.5

1.82

g/L

Chemistry laboratory

In the following we will discuss some of these tools and apparatuses.





- Digital balances are the most common.
- The top loading balance is the most commonly used digital balance.
- Before using the balance, you have to read the instructions which are present on one of its sides.



Top loading digital balance

Usage

• It is used to measure the masses of substances accurately.



Transparent beakers are made of pyrex glass (heat resistant).

Some beakers have definite capacity, some of them are graduated (beginning from the bottom to the top).



Graduated beakers

Usage

- Mixing the liquids and solutions.
- Transferring a known volume of liquid.

Graduated cylinders

Graduated cylinders are made of glass or plastic.

There are cylinders with different capacities, and they are usually graduated (beginning from the bottom to the top).

Usage

- Measuring the volumes of liquids where they are more accurate than flasks.
- Determining the volume of a solid body which doesn't dissolve in water.



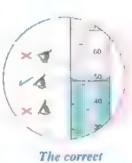
Graduated cylinders with different capacities



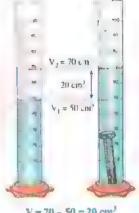
How can you determine the volume of a solid body which does not dissolve in water by a graduated cylinder?

- A suitable amount of water is placed in the cylinder and its volume is determined V₁
- The solid body is placed in that amount of water carefully inside the cylinder and the resulting volume is determined V₂
- The volume of the body V = the difference between the resulting volume and the volume of water alone.

$$\therefore \mathbf{V} = \mathbf{V}_2 - \mathbf{V}_1$$



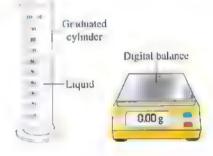
method to estimate the volume of a liquid



 $V = 70 - 50 = 20 \text{ cm}^2$

Worked Example

One of the students used the graduated cylinder which is shown in the opposite figure to measure a certain volume of a liquid, then he determined the mass of the graduated cylinder containing the liquid by using the digital balance. What should be measured to determine the density of this liquid?



- (a) The height of the liquid in the cylinder.
- (b) The mass of the empty cylinder.
- (c) The temperature of the liquid in the cylinder.
- (d) The volume of the empty cylinder.

Idea of answering:

To determine the density of any liquid, it is required to know the mass of a certain volume of it.

Density =
$$\frac{\text{Mass}}{\text{Volume}}$$

- : The volume of the liquid is determined by the graduated cylinder.
- : It is required to determine the mass of this volume of the liquid.
- : Mass of the liquid in the cylinder =

Mass of the cylinder containing the liquid - Mass of the empty cylinder

- : Mass of the cylinder contaming the liquid is determined by using the digital balance.
- .. It is required to determine the mass of the empty cylinder.

Answer: The correct choice is (b)





- Flasks are made of pyrex glass, because it resists heat, so they do not break with heating or by the effect of the heat of the chemical reactions.
- Flasks have many different capacities.

There are various types of flasks, according to their function and capacity like:



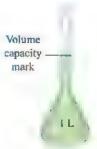
Conical flask

- It has a flat base.
- It is used in titration.



Round-bottom flask

- It has a rounded base.
- It is used in the chemical preparations and distillation.



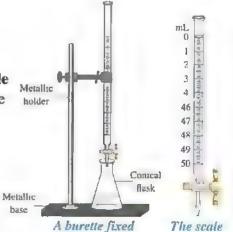
Volumetric flask

- There is a mark on its neck to determine the volumetric capacity.
- It is used to prepare solutions with very accurate known concentrations (the standard solutions).



- The burette is a long glass tube with two openings, the upper one is used in filling the burette with a solution and the other lower opening has a fixed valve to control the amount of solution dropped from it.
- In the burette, the zero mark on the graduation scale is close to the upper opening and the scale ends before the valve (i.e. its scale is from its top to its bottom).





on a holder

Usage

- It is used to measure volumes of the solutions with a high degree of accuracy during titration.
- The burette is fixed on a holder with a metallic base to preserve its vertical shape during the experiments.



Titration process is a neutralization process between an acidic solution and a basic solution to identify the concentration of the solution (with known volume) in the conical flask by knowing the volume and the concentration of the solution which is used in the burette.

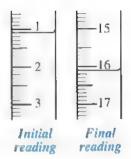
of the burette

Worked Example

The opposite figures represent two sections in one measuring tool:

Which of the following represents both the name of this tool, and the volume of the transferred liquid?

Choices	Tool	The volume of the liquid
(a)	Burette	16.1 mL
b	Graduated cylinder	16.1 mL
©	Burette	15 mL
(d)	Graduated cylinder	15 mL



Idea of answering:

- : The graduation scale of this tool begins from the top to the bottom.
- .. This tool is a burette.
- .. The choices (b) and (d) are excluded.
- : The volume of the liquid = Final reading Initial reading
- \therefore The liquid volume = 16.1 1.1 = 15 mL

Answer: The correct choice is ©

6 Pipelte

- It is a long glass tube opened from the two sides, recorded on it

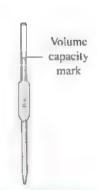
 the volume capacity and the error percentage (some of the pipettes have one
 bulb and some have two bulbs and the latter are the most common in laboratories).
- They are either graduated or of a predetermined capacity.



Graduated pipette



Pipette with a sucking tool



Pipette with one bulb

Usage

• It is used to accurately measure and transfer a certain volume of solution.

How to be used:

- Some of them are filled by mouth sucking and this must be with extreme caution.
- The others are supported with a sucking tool, because these are used with very hazardous materials (more preferred to be used).



Tools of measuring the pH value (hydrogen ion exponent)

pH value

A value which refers to the concentration of hydrogen ions H^+ in the aqueous solutions to determine the type whether acidic, basic or neutral, this value is represented by a scale which ranges from 0-14

Usage Measuring the value of pH of the solutions is very important in the chemical and biochemical reactions, because pH value determines if the solution is acidic, basic or neutral.

if pH < 7

if pH = 7

if pH > 7

The solution is acidic

The solution is neutral

The solution is basic or alkaline

* The value of pH is measured by :



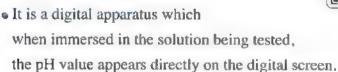
pH test paper

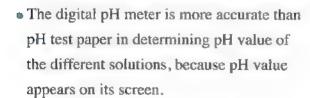


- It is a porous paper that is saturated with a pH indicator solution and then dried.
- When this paper is dipped in the solution being tested,
 it acquires a certain color which indicates a certain pH value.



pH-meter









A solution of pH value = 7



A solution of pH value = 3.2



Answer them yourself

Chanca	the co	react.	DESMOR	•
Choose	uie co	HICLL	allowe!	

Choose the correct answer	
(1) All the following are con	ntributions of chemistry in the production of the crops,
except	
a. producing suitable fer	tilizers.
b. the chemical analysis	of the soil.
c. expecting weather con	nditions.
d. producing effective in	secticides and pesticides.
(2) The science which studi	es the chemical structure of the carbohydrates in wheat plant is

a. biochemistry.	b. biology.
c. physical chemistry.	d. agriculture.
(3) Understanding and study of chemistry with	ying metabolism in living organisms represent the contributions
a. biology.	b. physics.
c. agriculture.	d. environment.
(4) The measuring tool whi	ch is used to measure the volumes of the liquids accurately
is	
a. flask.	b. beaker.
c. pipette.	d. graduated cylinder.
(5) Which of the following	is used in the processes of preparation and distillation?
a. Burette.	b. Pipette.
c. Sensitive balance.	d. Round-bottom flask.
(6) Pipette which is used in	measuring and transferring dangerous substances has
a. graduation.	b. one bulb.
c. two bulbs.	d. suction tool.



- (7) Quantitative measurement
 - a. includes a numerical value and a measuring unit.
 - b. doesn't include a numerical value.
 - c. always includes a comparison.
 - d. is achieved through practical experiments.

Complete the following table :

	Tool	Its function
(1)	** *************	Determining the volumes of liquids and the irregular solid objects.
(2)	h4444+>hh488+0006490	Mixing the liquids and the solutions.
(3)	* *11111000004440041	Adding accurate volume of liquids during titration.
(4)		Preparing standard solutions with a high accuracy.



Open book questions

Answered .



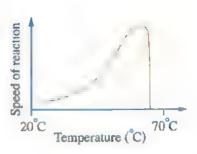


Chemistry is the central science

- The opposite graphical figure represents the effect of temperature on the activity of one of the human digestive enzymes, this represents the integration between chemistry and
 - a physics.

- (b) biology.
- c) pharmacy.

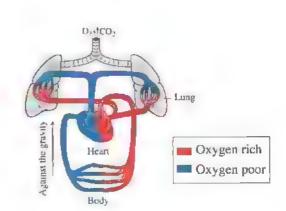
d agriculture.



- The science which is interested in studying the conversion of the liquid water to water vapour and vice versa in order to preserve the equilibrium in nature is the
 - a environmental chemistry.
 - b organic chemistry.
 - © analytical chemistry.
 - d physical chemistry.
- Most of the semi-solid paints become liquefied by the effect of the movement force caused by the paint brush used in painting.

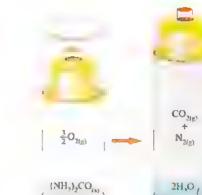
The previous statement exhibits a kind of integration between chemistry and

- a physics.
- (b) mathematics.
- © biology.
- (d) agriculture.
- The opposite figure represents the human circulatory system, this figure illustrates some sort of combination between
 - (a) chemistry and medicine only.
 - b chemistry and pharmacy only.
 - (c) chemistry, medicine and physics.
 - d chemistry, pharmacy and physics.





5 Urea $(NH_2)_2CO$ reacts with oxygen gas O_2 to form carbon dioxide gas CO2, nitrogen gas N2 and water H2O, the total volume of the produced gases is larger than the reactants volumes under the same conditions. What is the science which is interested in studying this kind of reactions?



- (a) Biochemistry.
- (b) Physical chemistry.
- (c) Environmental chemistry.
- (d) Analytical chemistry.
- 6 What is the science which is interested in the separation processes and the detection of the components of the substance qualitatively and quantitatively?
 - (a) Organic chemistry.
 - (b) Biochemistry.
 - (c) Analytical chemistry.
 - (d) Environmental chemistry.
- 7 Chemical engineers work at new factories including these which produce all the following, except the
 - (a) metals.

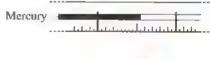
(b) cosmetics.

(c) tyres.

(d) seeds.

Importance of measurement in chemistry

8 A teacher covered the scale of a mercury thermometer to test the ability of a student to measure the boiling point of an unknown liquid. Which of the following represents the boiling point of that liquid, knowing that its boiling point is lower than that of water?



(a) 75.5°C

- (b) 84.5°C
- (c) 104.5°C
- (d) 105.5°C



Which of the following is incorrect regarding the importance of measurement?

Choices	Importance	Example
a	Monitoring	Determination of aspirin dose for a child.
b	Health care	Monitoring glucose in the blood of a diabetic patient.
©	Information	The proportions of the components of a milk package.
d	Management	Adding a basic substance to highly acidic soil.

The following tables represent 2 labels showing the nutritional components of 2 cans:

Nutrition Facts		
Fats 1 g		
Sugar	8 g	
Proteins	4 g	
Vitamin D	11%	
Iron	55%	
Vitamin A	44%	
Vitamin B ₆	44%	
Vitamin B ₁₂	100%	
Magnesium	22%	
Zinc	28%	

Nutrition Facts		
Fats	1 g	
Sugar	14 g	
Proteins	1 g	
Vitamin D	28%	
Iron	14%	
Vitamin A	21%	
Vitamin B ₆	35%	
Vitamin B ₁₂	35%	
Magnesium	0	
Zinc	14%	

Can (1)

Can (2)

Which of the following represents the can that contains the least percentage of minerals ? What is this percentage ?

Choices	Can	Percentage of minerals
(a)	(1)	28%
Ъ	(1)	13%
©	(2)	16%
<u>a</u>	(2)	28%



The following table shows the food components in 4 meals, the mass of each meal is 100 g:

The meal	Proteins	Fats	Carbohydrates	Sugar	Fibers
A	8.8 g	7.5 g	62.5 g	3.1 g	18.1 g
В	12 g	2.5 g	48 g	12.3 g	25.2 g
С	13 g	6.5 g	60.2 g	10.2 g	10.1 g
D	15.5 g	5 g	50 g	9.5 g	20 g

Which of these meals causes more weight gain when eaten a lot?

- (a) A
- (b) B

(c) C

(d) D

The following table shows the daily average of the different components of a meal which are obtained by the individuals A , B , C and D :

Individual	Nutritional components in the meal						
individual	Carbohydrates	Proteins	Fats	Calcium	Iron	Vitamin C	
A	590 g	350 g	110 g	2 g	15 mg	95 mg	
В	300 g	180 g	200 g	5 g	4 mg	100 mg	
C	500 g	120 g	50 g	0.1 g	30 mg	10 mg	
D	40 g	65 g	20 g	3 g	20 mg	80 mg	

Which of these individuals suffers from anaemia?

- (a) A
- (b) B
- (c) C
- (d) D

A diabetic patient had a breakfast composed of half a bread loaf, 200 g of potato, 4 spoons of beans and one medium apple, if you know that this patient needs to be injected by 2 units of insulin for each carbohydrate unit.

How many units of insulin are needed by the patient for this meal of breakfast?

- a 2 units.
- b 4 units.
- © 8 units.
- d 12 units.

	One carbohydrate unit in each of :
Ì	$\frac{1}{4}$ of a bread loaf
-	100 g potato

Measuring tools

In the opposite figure, a mixture of sand and water was poured in a funnel containing a filter paper, to measure the volume of water in this mixture. Which of the following tools can be used instead of a beaker to measure the volume of water accurately?





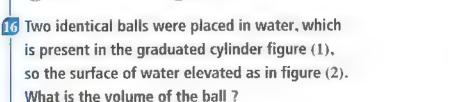






What is the volume of the liquid in the graduated cylinder which is illustrated in the opposite figure?

- (a) 5.6 mL
- (b) 5.7 mL
- © 5.8 mL
- (d) 5.9 mL

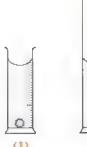


- (a) 2.5 cm^3
- (b) 5 cm³
- $(c) 10 \text{ cm}^3$
- (d) 22.5 cm^3

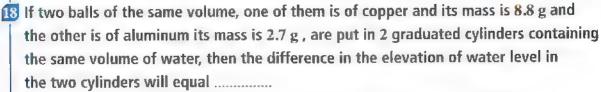


On moving the ball from the graduated cylinder (1) to the graduated cylinder (2) the graduation of the level of water which is present in the cylinder (1) decreased by 10 mL.

What is the increase in the graduation of the level of water in cylinder (2)?



- a 5 mL
- (b) 10 mL
- © 20 mL
- d) 40 mL



- (a) zero.
- (b) 2.7 cm^3
- © 6.1 cm³
- (d) 11.5 cm^3



The opposite figure represents a section in each of a burette and a graduated cylinder (in no particular order or consideration for the diameter of each of them).

Which of the following choices represents the correct readings ?

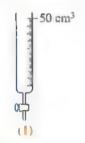
50	27
40	
30 —	28 -
(X)	(Y)

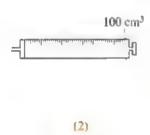
Choices	Burette reading (mL)	Graduated cylinder reading (mL)
a	44	27.8
b	27.8	44
0	27.8	42
(d)	28.2	44

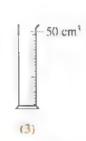
- What is the tool used in preparing potassium hydroxide solution to be used in the determination of the concentration of sulphuric acid?
 - (a) Burette.
 - (b) Round-bottom flask.
 - © Beaker.
 - (d) Volumetric flask.



21 The following figures show four measuring tools:







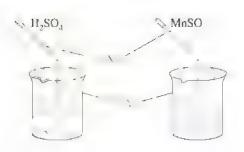


Which of the following represents the proper use of one of these tools?

Choices	Tool	Used in measuring		
(a)	(1)	16 cm ³ of an acid required to be added to an alkalı in a titration.		
Ь	(2)	I cm ³ of an acid required to be added to calcium carbonate in an experiment.		
0	(3)	75 cm ³ of a gas produced from a thermal decomposition reaction.		
<u>d</u>	(4)	20 cm ³ of an alkali required to be added to an acid in a titration.		

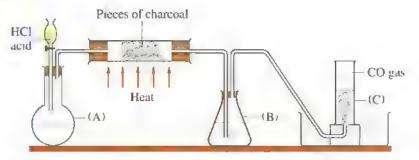
The tool (X) is used in transferring two different solutions to the tool (Y), which contains two other different solutions, a precipitate is formed in one of them but not in the other (as shown in the opposite figures) ..

What do you think about the properties of the solutions which are transferred by the tool (X) and about the utility of the tool (Y)?



Choices	Solutions transferred by the tool (X)	Utility of the tool (Y)
(a)	Safe	Mixing the solutions
(b)	Safe	Determination of the type of the precipitates
0	Not safe	Measuring the volumes of the solutions accurately
<u>d</u>	Not safe	Mixing the solutions

The apparatus shown in the following figure is used in the preparation of CO gas in the laboratory:



Which of the following is correct?

Choices	Tool (A)	Tool (B)	Tool (C)
a	Has a definite capacity	Graduated from the top to the bottom	Made of glass or plastic
Ь	Graduated from the bottom to the top	Used in measuring the volumes of the liquids accurately	Used in estimating the volume of a solid object insoluble in water
0	Made of pyrex	Some have definite capacity	Graduated from the bottom to the top
d	Used in titrations	Graduated from the bottom to the top	Used in transferring the highly dangerous liquids



A student wants to perform an experiment to measure the time of dissolving 2 g of magnesium completely in 100 mL of hydrochloric acid.

What are the required tools for this experiment?

- (a) Stopwatch, graduated cylinder, sensitive balance.
- (b) Graduated cylinder, thermometer, sensitive balance.
- © Stopwatch, sensitive balance.
- (d) Stopwatch, graduated cylinder.
- One of the students performed an experiment to measure the change in temperature on adding 25 mL of dilute hydrochloric acid to different volumes of sodium hydroxide solution. Which of the following tools the student would not need during the performance of the experiment?







(A)

(B)

3

Orange Yellow

(C)

Green

7

Solution

Colour

Hq



(D)

10

(E)

14

Blue Violet

5 different solutions are tested with pH paper tapes, they are coloured with the colours illustrated in the opposite table. What is the pair of the acidic solutions?

(a)	A	•	В
-----	---	---	---

There are two bottles one of them contains an acid and the other contains an alkali, they are required to be identified before being used in a titration.

What are the required tools for carrying out this experiment?

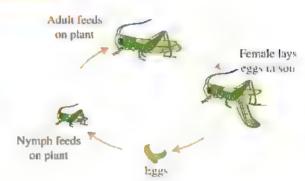
- (a) Pipette, burette, conical flask and pH meter.
- (b) Pipette, burette, round-bottom flask and pH meter.
- © Glass beaker, graduated cylinder, pipette, burette.
- (d) Graduated cylinder, pipette, burette, pH meter.

Essay questions

Chemistry is the central science

The opposite figure represents the life cycle of the locust:

- (1) What is the science which is interested in studying locust egg laying?
- (2) What is the role of chemistry in protecting the harvests from the locust?



Importance of measurement in chemistry

29 The opposite label is of a nutritional product whose volume is 128 mL:

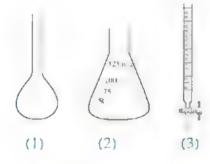
- (1) What is the importance of the presence of this label on the nutritional product?
- (2) Is this package suitable for the nutrition of a skinny person or a fat person? Explain. "Knowing that the minimum daily calories needed ranges between 150: 180 kcal"

Nutrition facts		
Calories	150 kcal	
Fats	0	
Sodium	10 mg	
Carbohydrates	27 g	
Fibers	4 g	
Sugar	18 g	
Protein	0	
Vitamin A	6%	
Vitamin C	45%	

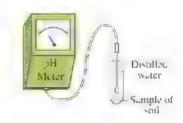
Measuring tools

Study the three tools which are illustrated by the opposite figures, then answer:

- (1) What is the difference between the tool (1) and the tool (2)?
- (2) What is the difference between the tool (3) and the pipette? And what is the similarity between them?



- The illustrated device in the opposite figure is used to measure the acidity or the basicity of the agricultural soil:
 - (1) What is the type of this soil? Explain.
 - (2) How can this soil be treated?



New types of questions 2 Answer

Choosing two out of five choices questions:

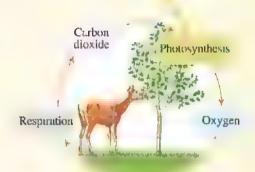
- 1 The opposite diagram represents the importance of O_2 and CO_2 gases for sustaining life, the processes show a clear integration between the two sciences
 - a chemistry.

b physics.

© geology.

d biology.

e pharmacy.



- Which of the following represents quantitative measurement?
 - (a) Sodium chloride is an ionic compound.
 - (b) The rate of reaction of ionic compounds is fast.
 - © The boiling point of water is 100°C
 - d Nitric acid is a strong acid.
 - (e) Methane gas contains 75% carbon.
- What are the two tools required to measure the density of petroleum oil?
 - a Graduated cylinder.

(b) Round-bottom flask.

© Burette.

(d) Volumetric flask.

- e Digital balance.
- Which of the following represents both the burette and the pipette?
 - (a) They are graduated from top to bottom.
 - (b) They are graduated from bottom to top.
 - © They are made of glass or plastic.
 - (d) They are used in measuring the volumes of the liquids.
 - e They are used in mixing liquids and solutions.
- All the following are similarities between the graduated cylinder and the burette, except that
 - (a) they are used in measuring the volumes of the liquids.
 - b) they are used in measuring the volumes of the solid objects.
 - (c) they are made of glass.
 - d they are graduated tools.
 - e they are used in titration processes.



Liching mi lawatherigg



• There are some derived words from the SI basic units differ from each other by powers of ten (decimal exponent 10ⁿ).

These derived words are called SI Prefixes.

Amount	Decimal exponent (10 ⁿ)
1000 000	106
0,001	10 ⁻³

• The following table shows some of SI Prefixes:

SI Prefixes	Abbrevlation	Multiple (10 ⁿ)	Examples
Kito	k	10 ³	1 Kilo meter = 10^3 meter 1 km = 10^3 m
Decl	d	10-1	1 Decimeter = 10^{-1} meter 1 dm = 10^{-1} m
Centi	e	10 2	1 Centimeter = 10^{-2} meter $1 \text{ cm} = 10^{-2} \text{ m}$
Milli	m	10-3	1 Millimeter = 10^{-3} meter 1 mm = 10^{-3} m
Micro	μ	10 6	1 Micro meter = 10^{-6} meter 1 μ m = 10^{-6} m
Nano	n	10 ⁻⁹	1 Nanometer = 10 9 meter 1 nm = 10 9 m

🤾 Which is more harmful, 🗕

the concentration of lead in a river water when it equals a part per billion or when it equals a part per million? Why?

The more harmful is when it equals a part per million 1×10^{-6} as this amount is larger than when it equals a part per billion 1×10^{-9}

3

Test-Vourseif

Which of the following measuring relations is incorrect?

- (a) 1 microliter = 1×10^{-6} L
- (b) 1 gram = 1×10^{-6} kg

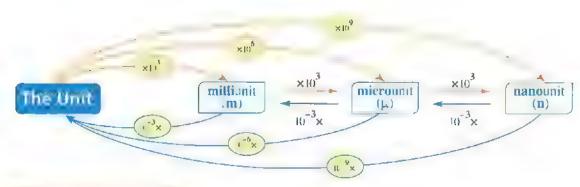
© 1 liter = 10^3 mL

(d) 10² centigram = 1 g

Answer: The correct choice is

The relation between milli . micro and nano

- Milli $(\frac{1}{1000} \text{ of unit}) > \text{micro} (\frac{1}{1000000} \text{ of unit}) > \text{nano} (\frac{1}{100000000} \text{ of unit}).$
- The following diagram shows how to convert from the measuring unit to its milli, micro or nano and vice versa:



Worked-Examples

Which of the following represents the least mass of a chemical powder?

(a) 100 μg

(b) 1000 ng

© 1 mg

(d) 0.01 g

Idea of answering:

- (a) $100 \mu g = 100 \times 10^{-6} g = 1 \times 10^{-4} g$
- **(b)** $1000 \text{ ng} = 1000 \times 10^{-9} \text{ g} = 1 \times 10^{-6} \text{ g}$
- © 1 mg = 1×10^{-3} g = 1×10^{-3} g
- (d) $0.01 \text{ g} = 10^{-2} \text{ g}$

Answer: The correct choice is **b**

Uranium is supposed to exist in earth's crust in an average concentration of 4 g for each 1 ton of earth's crust. What is the mass of uranium which exists in 1.5 mg of earth's crust?

(a) 6 ng

b 6 μg

(c) 6 mg

 $\bigcirc 6 \times 10^{-5} \text{ g}$

Idea of answering:

1 ton = 1000 kg, 1 kg = 1000 g, 1 g = 1000 mg

∴ 1 ton × $\frac{1000 \text{ kg}}{1 \text{ ton}}$ × $\frac{1000 \text{ g}}{1 \text{ kg}}$ × $\frac{1000 \text{ mg}}{1 \text{ g}}$ = 1 × 10⁹ mg

 $\therefore 1 \text{ ton} = 1 \times 10^9 \text{ mg}$

Earth's crust $\xrightarrow{\text{Contains}}$ Uranium $1 \times 10^9 \text{ mg}$ 4 g 1.5 mg ? g

 $\therefore \text{ The mass of uranium} = \frac{4 \times 1.5}{1 \times 10^9} = 6 \times 10^{-9} \text{ g} - 6 \text{ ng}$

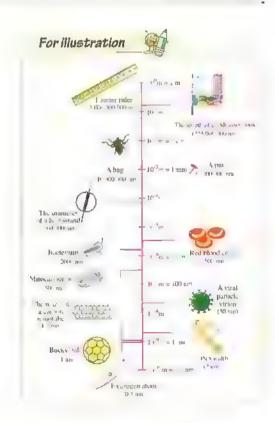
Answer: The correct choice is (a)

Nano scale

- Nano is a prefix which precedes the measuring units, such as:
 - Nanometer (nm).
- Nanogram (ng).
- Nanosecond (ns).
- Nanojoule (nJ).

Nano scale is the scale of the extremely small particles whose diameters range between 1:100 nm

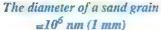
Substances gain unique properties in the Nano scale differ from their properties in macro or micro scales.



• The following examples show how small the nanometer unit is:

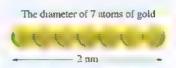








The diameter of a water molecule is approximately 0.3 nm



The diameter of an atom ranges from 0.1:0.3 nm

Critical Nano volume is the volume in which the unique Nano properties of the substance appear, each dimension of this substance is less than 100 nm

• These properties change according to the change in the Nano volume and they are called Volume dependent properties.

As the case in:

- Chemical properties like the speed of chemical reactions, where the number of atoms of
 the surface of the substance which is exposed to the reaction (in nano volume) becomes
 very large compared to the macro volume of the substance.
- Physical properties like color, transparency, melting point as well as heat conductivity and electric conductivity.
- Mechanical properties like hardness and elasticity.

Examples of Nano properties

The sharpe of cold so

The change of gold color according to the change of the Nano volume

but on reducing its particles volume to the Nano volume, it takes different colors like:

Red, orange, green or blue according to its

Nano volume, because the interaction of gold particles in Nano scale with light differs from its interaction with light in macro scale.

It's known that gold has a bright yellow color,



Changing the gold color according to its Nano volume



B The change of copper hardness according to the Nano volume

- The hardness of copper increases by decreasing the volume of its particles to be in Nano volume.
- Copper hardness varies with its particles Nano volume.



Nano copper powder

Explanation of the unique (unusual) behavior of Nano substances

• The unique (unusual) properties of Nano substances are due to the relation (ratio) between the surface area and the volume.

I The state of the

The relation between the surface area and the volume of a cube.

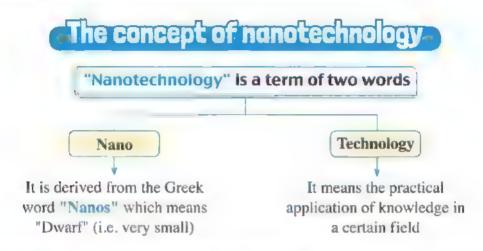
On dividing a cube of a side length 1 cm to many cubes, the total surface area of cubes increases, while the total volume of the cubes is still constant, as shown in the following table:

Figures	1 (-1	1, -m	
Length of the cube side (L)	1 cm	1/2 cm	1/3 cm
Number of cubes	1	8	27
Total surface area = (L ²) × 6 faces × no. of cubes	$(1 \text{ cm})^2 \times 6 \times 1$ $= 6 \text{ cm}^2$	$(\frac{1}{2} \text{ cm})^2 \times 6 \times 8$ $= 12 \text{ cm}^2$	$\left(\frac{1}{3} \text{ cm}\right)^2 \times 6 \times 27$ $= 18 \text{ cm}^2$
Total volume = (L ³) × no. of cubes	$(1 \text{ cm})^3 \times 1$ $= 1 \text{ cm}^3$	$(\frac{1}{2} \text{ cm})^3 \times 8$ $= 1 \text{ cm}^3$	$(\frac{1}{3} \text{ cm})^3 \times 27$ $= 1 \text{ cm}^3$
The ratio between the surface and the volume Surface area Volume	$\frac{6}{1} = 6$	12 1 = 12	18 1 = 18

With more division in the cube, the ratio between the surface area and the solume increases, when the particles of the substance become in nano volume, the ratio between the surface area and the volume will increase to a very large value.

So it will provide the substance with new and unique physical and chemical properties.

• It is clear that fine powdered sugar dissolves in water faster than a block cube, in the same amount of water and at the same temperature, because sugar powder has a greater ratio between the surface area and the volume than that of a sugar cube. So more number of molecules will be exposed to the dissolving process at the same time.



Nanotechnology can be defined as the technology of very small substances and it deals with the substances in the Nano scale to produce new substances with new, useful and unique properties.

Nanochemistry

Nanochemistry: It is one of the Nano science branches

which:

- ① Deals with chemical applications of Nano substances.
- Includes studying, describing and the synthesis of Nano substances.
- 3 Studies the unique properties related to collecting atoms and molecules which have Nano dimensions.



Nano balls

Nano substances may take different shapes as follows

Particles.

- Nanotubes.
- · Nano columns.
- Nanofibers.
- Nano wires.
- Thin films.

Balls.

- Thin membranes.
- Any substance, no matter how small its volume is, has three dimensional structure (length, width and height)

Nano substances are classified according to their Nano dimensions into:



One-dimensional Nano substances



Two-dimensional Nano substances



Three-dimensional Nano substances



One dimensional Nano substances

One-dimensional Nano substances are Nano substances that have one Nano dimension.



Thin films



Nano wires



Nanofibers



Used in

Used in

- Packaging food products to protect them from getting spoiled or rotten.
- Painting surfaces to protect them from rusting and corrosion.

Manufacturing electric circuits

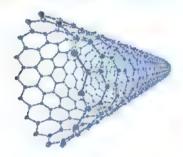
Production of water filters

Two-dimensional Mano substances

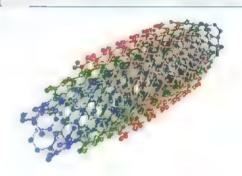
Two-dimensional Nano substances are Nano substances that have two Nano dimensions.



Single-walled carbon Nanotube



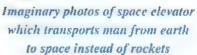
Multi-walled carbon Nanotube



Carbon Nanotubes are:

- 1. Good conductors (superconductors) of electricity (where their conductivity exceeds that of copper).
- 2. Good conductors (superconductors) of heat (where their conductivity exceeds that of diamond).
- 3. Stronger and lighter than steel, due to the powerful bonds between their molecules, therefore the Nanotubes which have the size of a human hair can easily pull a truck. Therefore, scientists think of inventing very strong robes that can be used in the future to make space elevators (shuttles).
- 4. Connected easily to protein. Therefore, they can be used in making biological sensor devices which are sensitive to certain molecules.







Three dimensional Nano substances

Three-dimensional Nano substances are Nano substances that have three Nano dimensions.



Bucky ball C60

Bucky ball C60

Each carbon atom is linked to three carbon atoms

- Bucky ball C60 consists of 60 carbon atoms.
- It is characterized by a group of special properties, which depend on its molecular structure.
- 3. The molecular model of the bucky ball appears as a hollow football. So scientists test the effectiveness of using it as a carrier for medicines in the body, as its hollow structure allows it to hold the molecules of medicine inside it and protects them from the reaction with other molecules inside the body.



Nano shell Core

Used in treating cancer

For Illustration



- * Nano shell consists of :
 - Core: It is made of insulating substances.
 - Shell: It is made of very thin metallic cover (almost gold).

Worked Example

The following table shows the dimensions of four different substances

(A), (B), (C), and (D):

Substance	Length	Width	Height
(A)	1.2 × 10 ⁻⁸ m	200 × 10 ⁻¹⁰ m	$322 \times 10^{-10} \text{ m}$
(B)	$21 \times 10^{-10} \text{ m}$	$0.18 \times 10^{-5} \text{ m}$	17.9 × 10 ⁻⁹ m
(C)	$130 \times 10^{-7} \text{ m}$	49 × 10 ⁻⁷ m	68 × 10 ⁻⁶ m
(D)	$1.7 \times 10^{-8} \text{ m}$	$83 \times 10^{-4} \text{ m}$	$96 \times 10^{-3} \text{ m}$

What is the correct ascending order of these substances according to their hardness?

$$(b)$$
 D > A > C > B

$$\bigcirc A > B > D > C$$

$$(d)$$
 D>C>A>B

Idea of answering:

It is necessary to convert the measuring units of the dimensions from (m) to (nm) by multiplying $\times 10^9$

Substance	Length	Width	Height
(A)	12 nm	20 nm	32.2 nm
(B)	2.1 nm	1800 nm	17.9 nm
(C)	$13 \times 10^3 \mathrm{nm}$	4900 nm	$68 \times 10^3 \mathrm{nm}$
(D)	17 nm	83 × 10 ⁵ nm	96 × 10 ⁶ nm

- · Nano scale ranges between 1:100 nm
- .. These 4 substances are classified as shown:
- The hardness of the substance increases by increasing the dimensions of its nanoparticles.
- (A) Three dimensional nano substance
 (B) Two dimensional nano substance
 (C) It is not a nano substance
 (D) One dimensional nano substance
- ∴ The correct ascending order of the substances according to their hardness is: A > B > D > C

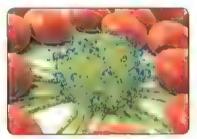
Answer: The correct choice is ©

Applications of Nanotechnology

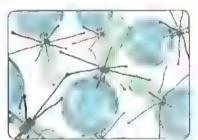


Medical field

- 1 The early diagnosis of diseases and picturing of organs and tissues.
- Accurate delivering of a medicine to the infected tissues and cells, which increases the chances of healing and decreases the harmful side effects of the traditional healing methods which don't distinguish between the infected cells and the other healthy ones.
- Producing Nanorobots that enter the body through the bloodstream to remove blood clots from the vein walls without surgical interference.



Delivering the medication to the infected cells by a nanorobot



Removing cancerous cells by a nanorobot

- O Producing extremely small devices for dialysis that are implanted in the body of the patient who suffers from kidney failure.
- **B** Agricultural field
- Preserving food.
- 1 Identifying bacteria which are found in nutrients.
- 1 Improving nutrients, pesticides and medicines for plants and animals with special features.
- **Energy field**
- Producing solar cells by using Nano silicon which has a great ability to convert solar energy into electrical energy and avoid the leakage of heat energy.
- Producing hydrogen fuel cells, with a high performance and low cost.
- Industrial field
- Producing invisible Nano molecules, which give the glass and ceramics the property of self-cleaning.







Solar cells with Nano silicon

- Producing Nano substances to purify sun rays from ultraviolet rays in order to improve sunblock cosmetics and creams.
- Or Producing Nano wrapping technology in the form of paints and sprays to protect the screens of electrical devices from scratching.
- Producing dirt removing fabrics that are characterized by the self-cleaning property.







Dirt removing nano-textile

Communications field

- 1 Producing wireless Nano devices, mobiles and satellites.
- Decreasing the size of transistors.
- Producing electronic chips that are characterized by a high storage capacity.

For illustration



Transistor is a semiconductor device, used in most electrical devices to control the flow of the electric current.

Environmental field

Producing Nano filters which are used in:

- 1 Purification of air and water.
- Desalination of water,
- Solving the nuclear wastes problem.
- Elimination of the dangerous elements from the industrial wastes.

The possible harmful effects of Nanotechnology

A Environmental effects

During the production of Nano substances, there are many wastes which can be very dangerous, because they may be suspended in air, then enter water and soil and they may easily penetrate the animal and plant cells, this is called Nano pollution which is the pollution caused by the wastes produced from preparing Nano substances, it affects each of water, air, soil and even the climate.

B Medical effects

The very minute Nanoparticles may penetrate the body of human or animal through the cell membrane of the skin and lungs causing diseases.

Social effects

The social and economic problems between the rich world countries and the developing countries may increase, due to the unequal distribution of technology and economic resources.



Fredminary quartitions to remember the main to get to the least of

Answer them yourself

Choose the correct answer:

(1) Which of the following represents the change in the surface area and the volume of a cube of sugar when it is grinded?

Choices	Surface area	Volume
a.	Increases	Increases
b.	Does not change	Does not change
c.	Increases	Does not change
d.	Does not change	Increases

•	- " "	es of the nano substanc	es is the very large rati
between volume	and		
a. length.	b. density.	c. mass.	d. surface area.
(3) All the following	g are one-dimensional	nano substances, exce	pt
a. thin films.	b. nano wires.	c. nano fibers.	d. nano shell.
(4) From the two-d	imensional nano substa	nces is (are)	
a. carbon nanoti	ubes.	b. bucky ball.	
c. nano shell.		d. nano fibers.	
(5) The substance v	hich can be used as a ca	arrier for a medicine in	the body is
a. nano shell.	b. nano silicon.	c. bucky ball C60	d. nano fiber.
(6) From the moder	m technologies in treati	ng coronary artery blo	ckage is
a. the bucky bal	1.	b, the nanorobot.	
c. the nano shel	1.	d. a carbon tube.	
(7) From the applic	ations of nanotechnolo	gy in the environment	al field are
a. wireless nanc	devices.	b. nano filters.	
c. dirt removing	textile.	d. hydrogen fuel c	ells.



2 Give reasons for :

- (1) Nano is a unique scale.
- (2) The color of gold changes when the dimensions of its particles change from macro scale to nano scale.
- (3) Carbon nanotubes are stronger than steel.
- (4) The bucky ball is denoted by C60
- (5) Nanotechnology may violate the principle of equality.

What are the results of :

- (1) Reducing the volume of gold particles to the nano volume.
- (2) Reducing the volume of copper particles from macro scale to nano scale.
- (3) The penetration of the very minute nanoparticles to the cell membranes of the skin, then to the body.



Open book questions

: Answered :







Prefixes

- What is the value of 0.03 s in nanoseconds?
 - (a) 3×10^9 ns

(b) $3 \times 10^7 \, \text{ns}$

- (c) 3×10^5 ns
- (d) 3×10^3 ns
- Which of the following substances has the largest mass?
 - (a) 1000 mg of gold.
- (b) 1 kg of rice.
- (c) 10000 g of meat.
- (d) 10000 mg of feather.
- The amount 0.398 m equals
 - (a) 398 mm

- (b) 3.98×10^{-3} mm
- (c) 3.98 × 10^{-4} mm
- (d) 0.0398 mm
- What is the value of 15.7 mL of a liquid in nanoliters?
 - (a) 157 nL

- (b) 2.62 nL
- © $1.57 \times 10^7 \, \text{nL}$
- (d) $1.57 \times 10^{-5} \,\mathrm{nL}$
- 5 Which of the following pairs of masses is equal?
 - (a) $10^2 \, \mu g / 10^8 \, ng$
- (b) $10^8 \text{ ng} / 0.1 \text{ mg}$
- © 0.1 mg / 0.001 g
- (d) $10^2 \mu g / 0.1 mg$
- The opposite figure shows a graduated cylinder. What is the suitable measuring unit which is

used to measure the volumes in the graduated cylinder?

(a) mm²

(b) mm³

(c) cm²

- $\boxed{0}$ A doctor has prescribed 0.125 g of ampicillin for a patient, if each 5 mL of the ampicillin syrup medication contains 250 mg of ampicillin. What is the volume which is required for the patient in each dose?
 - (a) 5 mL
 - (b) 2.5 mL
 - (c) 1.25 mL
 - $(d) 0.75 \, mL$



Questions marked

by this mark



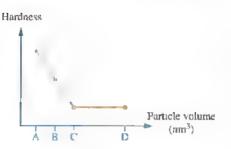
Nano scale

- 8 Which of the letters which are illustrated on the opposite graphical figure represents the critical nano volume of the particles of a nano substance?
 - (a) A

- (c) C The opposite figure represents the hardness of 4 nanostates of a sample of an element. Which of these states its total surface area is the largest?

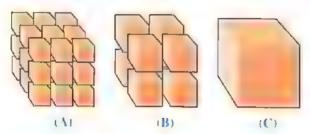


- (b) B
- (c) C
- (d) D





10 The following figures represent 3 samples of the same substance, the mass of each of them is 50 g, when they were dissolved in 500 mL of water - each individually - at room temperature, it was found that the rate of dissolution of the sample (C) is the lowest.



What is the scientific explanation for that? The sample (C) has the

- (a) largest volume.
- (b) smallest surface area.
- (c) highest number of particles.
- (d) lowest density.

Nanochemistry

- 11 To be described as a nano particle, this particle should
 - (a) be unidimensional.
 - (b) have length and width which are measured in nano scale.
 - () have length, width and height.
 - (d) have at least one nano dimension.

The screen of the mobile phone is covered with nano liquid to form a thin layer on its surface to protect it from scratching and breaking.

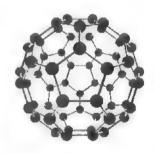
What is the type of the material used in manufacturing this nano liquid?

- (a) Colloidal substance.
- (b) One-dimensional nano substance.
- © Suspended substance.
- (d) Two-dimensional nano substance.
- Which of the following choices expresses the dimensions of a two dimensional nano substance ?

Choices	Length	Width	Height
a	1.2×10^{-11} m	$200 \times 10^{-10} \text{ m}$	$320 \times 10^{-12} \text{ m}$
b	$21 \times 10^{-10} \text{m}$	0.18 × 10 ⁻⁵ m	$17.9 \times 10^{-9} \text{ m}$
0	$130 \times 10^{-7} \text{ m}$	49 × 10 ⁻⁷ m	$68 \times 10^{-6} \text{ m}$
d	$17 \times 10^{-8} \text{ m}$	$83 \times 10^{-4} \mathrm{m}$	$96 \times 10^{-3} \text{ m}$

What are the possible dimensions of the opposite figure?

Choices	Length	Width	Height
a	322 nm	83 nm	720 nm
(b)	179 nm	180 nm	11 nm
©	86 nm	94 nm	91 nm
d	196 nm	201 nm	278 nm



15 🌉 If the nanodimensions of the bucky ball are :

$$(86 \times 10^{-9} \text{ m} / 9 \times 10^{-8} \text{ m} / 910 \times 10^{-10} \text{ m})$$

Which of the following represents the possible dimensions of the particles of the medicine transferred by this ball ?

Choices	Length	Width	Height
a	86 nm	94 nm	910 nm
b	86 nm	90 nm	91 nm
©	$250 \times 10^{-10} \text{ m}$	27 nm	$180 \times 10^{-10} \text{ m}$
<u>d</u>	$650 \times 10^{-9} \text{ m}$	$9 \times 10^{-7} \text{m}$	98 nm

What is the number of carbon atoms which are linked to each carbon atom in each of bucky ball, and the carbon nanotube ?

Choices	in bucky ball	In carbon nanotube
(a)	3	3
b	2	3
0	3	2
(d)	6	6

What is the difference in the bonding of carbon atoms with each other in each of bucky ball, and the carbon nanotube?

Choices	Carbon atoms of bucky ball	Carbon atoms of the carbon nanotube
(a)	bound to each other forming pentagons	bound to each other forming hexagons
(b)	bound to each other forming hexagons	bound to each other forming pentagons
0	bound to each other forming pentagons and hexagons	bound to each other forming hexagons
(1)	bound to each other forming hexagons	bound to each other forming pentagons and hexagons

6 0	One of the uses of the three-dimensional nano substances is to		
10	Wile Of the USES of the Inter-almensional hand substances is to	%	
	are at the ages of the filler difficultional liquid 2003 (diffee 12 ff		

- a manufacture nanorobots.
- (b) target the infected cells with the proper medication.
- c target crawling insects.
- (d) manufacture geological scanners.

Applications of nanotechnology

- Nano particles which are covered with gold are used in the treatment of
 - a visual impairment.
 - (b) athlete's foot.
 - c breast cancer.
 - d round worm.

In the light of the interest of the scientists in reducing the consumption of the aviation fuel, there are attempts being made to replace the copper conductors with plastic conductors known as polyaniline.

Which of the following can be added to polyaniline to render it a better electric conductor than copper?

- (a) Carbon nanotubes.
- (b) Bucky ball.
- © Nano shell.
- (d) Nano wires.
- 21 The opposite figures represent two solar cells, if these two cells are operated for the same period of time, then
 - (a) the temperature of the cell (A) is equal to that of the cell (B).





Solar cell of nanosilicon (B)

- (b) the temperature of the cell (A) is lower than that of the cell (B).
- c the quantity of the electricity generated from the cell (A) is larger than that generated from the cell (B).
- d the quantity of the electricity generated from the cell (A) is less than that generated from the cell (B).



Prefixes

There are 5 different physical quantities :

2 m³ 0.5 g 0.5 kg 600 cm² 20 mm

Use the scientific sense to determine the suitable unit for each of the following:

- (1) The mass of a small paper clip.
- (2) The length of a small paper clip.
- (3) The volume of a freezer in a refrigerator.
- (4) The surface area of a book cover.

- (5) The mass of a jam jar.
- Calculate the quantities produced from converting :
 - (1) 1.445 m to km

(2) 2.41 cm to m

(3) 235.3 m to mm

(4) 903.3 nm to μm

(5) 8.43 cm to mm

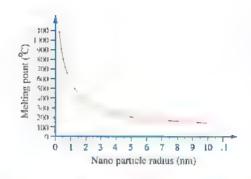
(6) 294.5 nm to cm



Nano scale

24 Study the opposite graph, then answer the following:

- (1) What is the relation between the melting points of nano substances and their particles radii?
- (2) Which is higher the melting point of silver particles in micro scale or nano scale?



25 The opposite figure represents two types of gold rings, rings (1) are red, while ring (2) is golden. What is the scientific explanation of the red colour of the rings (1)?



Nanochemistry

Sesame seeds are characterized by containing a large amount of oil, equals approximately half the mass.

Tahini is the blend produced from the solid substances which result from the fine grinding of the roasted sesame seeds and the oil that is yielded from them, in the light of your understanding of the unique properties of nano substances, illustrate the reason of the different taste of tahini from the taste of sesame of which it is made.

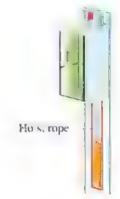
27 The following table shows the three dimensions of four different substances:

Substance	Length	Width	Height
(W)	$17 \times 10^{-8} \text{ m}$	$83 \times 10^{-4} \text{ m}$	$96 \times 10^{-3} \text{ m}$
(X)	$111.2 \times 10^{-11} \text{ m}$	$201 \times 10^{-10} \text{ m}$	3332.2 × 10 ⁻¹² m
(Y)	$21 \times 10^{-10} \text{ m}$	$0.18 \times 10^{-5} \text{ m}$	17.9 × 10 ⁻⁹ m
(Z)	$130 \times 10^{-7} \text{ m}$	$49 \times 10^{-9} \text{ m}$	68 × 10 ⁻⁶ m

Mention the symbol of the substance which is:

- (1) Not a nano substance.
- (2) One-dimensional nano substance.
- (3) A gold nano shell.

The opposite figure shows an elevator car which is suspended by the hoist rope, which is made of braided steel which in turn is formed of strands, each strand has a diameter ranges between 6: 11 mm, what is the future alternative of the steel rope which is characterized by the following properties:



- It is much lighter than steel.
- Its diameter = 60000 nm (a hair strand diameter).
- Bucky ball can be used in storing hydrogen gas which is used as fuel in some modern cars, why is the molecular model of bucky ball eligible for storing hydrogen?
- Yacoub dreams to use in his field to carry out operations without surgery. Suggest a medical importance for the nanorobot.





Choosing two out of five choices questions:

1 Which of the following substances can have these dimensions?

$0.11 \times 10^{-10} \text{ m}$	$0.18 \times 10^{-5} \text{ m}$	$320 \times 10^{-11} \text{ m}$
----------------------------------	---------------------------------	---------------------------------

(a) thin films.

- (b) bucky balls.
- (c) carbon nanotubes.
- d nano wires.
- (e) nano shells.
- 2 The substance whose dimensions are: (196 nm / 87 nm / 91 nm) can be used in
 - (a) producing water filters.
 - (b) making space elevators.
 - c covering car roofs.
 - d delivering medicine to infected cells.
 - (e) making biological sensor devices.
- The dimensions of the particles of a substance are : (79 nm / 92 nm / 81 nm)

 Its molecule is composed of 60 similar atoms, two characteristics of this substance are
 - (a) its electrical conductivity.
 - (b) its high hardness.
 - © its inertness to human body.
 - (d) that it is hollow.
 - e that it binds easily to protein.
- If one of the dimensions of the substance used in curing cancer is X = 30 nmWhat are the possible dimensions Y and Z of this substance?
 - (a) 10^{-3} nm

(b) 10 nm

(c) 10^3 nm

(d) 30 nm

@ 300 nm

Exam model on Unit 1











Questions marked

Answered

A student wanted to calculate the speed of the reaction of diluted sulphuric acid with a definite mass of zinc at 35°C, so he prepared a bottle of the acid and a glass beaker.

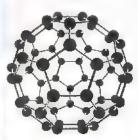
What are the other tools that are required for this experiment?

- (a) Sensitive balance, stopwatch and graduated cylinder.
- (b) Sensitive balance, stopwatch and thermometer.
- © Flask, graduated cylinder and thermometer.
- (d) Stopwatch, graduated cylinder and thermometer.
- Which of the following represents graduated cylinder, burette, pipette and the flask correctly?

Choices	Graduated cylinder	Burette	Pipette	Flask
a	Used in heating liquids	Graduated from top to bottom	Some have definite capacity	May have 1 L capacity
ь	Used in collecting gases	Measures the volumes of gases	May be provided by a suction tool	May be rounded
©	Graduated from bottom to top	Graduated from top to bottom	Graduated from top to bottom	Made of plastic
d	Graduated from bottom to top	Used in titrations	Some are graduated	Able to be heated

- - (a) three-dimensional nano substances.
 - (b) two-dimensional nano substances.
 - (c) multi-dimensional nano substances.
 - d one-dimensional nano substances.





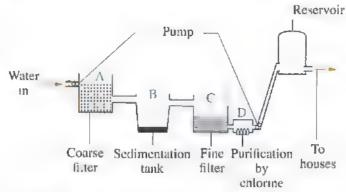
(A)

(B)

- The volume of nano shell and the thickness of gold nano layer which covers the shelf affect.
 - (a) its density.
 - (b) its colour.
 - c) its odour.
 - d its taste.
- 5 Two different shoes are dipped in two dyes, one of them is coloured by the dye and the other is not, as shown in the figure, this is explained by the fact that
 - (a) the solution which is used in case (1) is not a nano solution.



- (b) the solution which is used in case (2) is a nano solution.
- c) the shoe which is used in case (1) is made of plastic.
- d the shoe which is used in case (2) is covered with a stain repellent nano substance.
- The main source for drinkable water in Egypt is the river of the Nile, so to separate and dispose the particles of silt, chemical substances and bacteria which exist in it, purification and treatment of water are carried out in several stages (illustrated in the following figure):



In which of these tanks are the nano fibers used ?

(a) A

(b) E

© C

- (d) D
- The quantity of oil in the opposite vessel equals



ⓑ
$$5 \times 10^{-4} \, \text{m}^3$$

$$\odot 5 \times 10^{15} \, \mu \text{m}^3$$

(d)
$$5 \times 10^{22} \, \text{nm}^3$$



- 8 What is the science which is interested in studying the composition of matter, the change in energy and the laws which explain the conversion of matter from one form to another?
 - (a) Inorganic chemistry.
 - (b) Organic chemistry.
 - (c) Analytical chemistry.
 - (d) Physical chemistry.
- The following dimensions are of a nano ceramic particle:
 - 320 nm
- 135 nm
- 40 nm

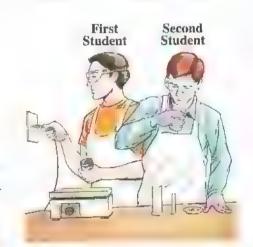
This particle is a

- (d) one-dimensional nano substance.
- (b) two-dimensional nano substance.
- (c) three-dimensional nano substance.
- (d) multi-walled substance.
- 10 ___ A meal includes 19 g of protein, 19 g of carbohydrates and 10 g of fats, this meal provides a person with 240 kcal, so if you know that each 1 ${f g}$ of fats burns releasing 9 kcal

What is the percentage of energy resulting from the fats in this meal?

- (a) 30%
- (b) 34%
- (c) 37.5%
- (d) 42%
- 111 The opposite figure shows two students in chemistry lab, each of them did a mistake which violates the safety and security measures in the laboratories, identify the mistake of each of them.
 - · The first student's mistake:
 - The second student's mistake:







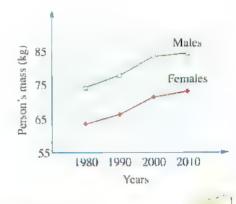


The opposite figure represents a section in earth rocks, the rocks (V) are layers of limestone CaCO,, they are formed of tiny crystalline particles whose volume starts from (0.001 m³): (1) What is the kind of integration between sciences in the previous paragraph? (2) Calculate the smallest volume of limestone crystals in nano scale. 13 The opposite figure represents the correct way cm^3 to estimate the volume of a liquid in one of the measuring tools in lab: (1) What is the volume of the liquid? Liquid (2) What is the name of this tool? Explain. Why are carbon nanotubes better than any other metal in manufacturing planes chassis ?

Levars

The opposite graph represents the change in the masses of the bodies of the youth (males and females) by time.

Suggest one technological reason to explain the change.



The opposite figure represents what happens to the particles of dust which cover a glass surface painted with an invisible substance when water falls on it.

What is the type of this invisible (transparent) substance, and what is the property which characterizes this substance?





Viruses attack the intact cells through the protein which surrounds their membrane, in the same way the scientists try to destroy the cancer cells by synthesizing a protein that combines with the membrane of these cells, and then attacking them by nanounits carrying the proper chemical substances to destroy these cells alone without affecting the other intact cells.

What are the nanounits that can be used for this purpose?





Quantitative Chemistry



The Mole and the Chemical Equation.

Writing the chemical formulas of the compounds.

From Chemical equation.
Until Before the mole.

From The mole.

Until Before the mole and Avogadro's number.

From The mole and Avogadro's number

Until The end of the chapter.

Calculation of the Chemical Formula.

Exam model on the unit



> By the end of this unit, the student will be able to :

- Express a chemical reaction using a balanced symbolical equation.
- a Calculate the mass of the mole of a chemical compound by using the atomic mass.
- Mention the relationship between the mole and Avogadro's number.
- · Identify the molar volume of gas at (STP).
- Calculate the number of moles of gas by using its volume and molar volume.
- Calculate the mass percentage of the components of a substance by using its chemical formula or with the experimental results
- Deduce an empirical formula and a molecular formula of the compound by using the experimental results.
- Calculate the amounts of reactants and products in the balanced chemical equation.
- ▶ The included life topic: Rationalization of consumption.

Writing the chemical formulas of the compounds



• Most of the elements of the periodic table exist in the form of monatonic molecules, such as:



• Only 7 of these elements exist in the form of diatomic molecules, which are:



• The following table represents the difference between the symbols of the atoms, ions and the molecules of some elements and the chemical formulas of the molecules of some compounds:

C Carbon atom. O Oxygen atom. 1 Wo uncombined oxygen atoms. O Negative oxygen non. O Oxygen molecule formed of the combination of two oxygen atoms. CO Carbon monoxide molecule formed of the combination of one carbon atom with one oxygen atoms.



Carbon dioxide molecule formed of the combination of one carbon atom with two oxygen atoms.

Two carbon dioxide molecules.

The thereise featesing of the compounds and their name

- * This prelude (introduction) is about acquiring the skill of writing the chemical formulas of the compounds and their names, particularly:
 - [] Ionic compounds.
- Ocvalent compounds.
- Acids.



lonic compounds

The ionic bond results from :

Combination of









A positive ion of a metal atom or a positive atomic group A negative ion of a nonmetal atom or a negative atomic group

* Here are some examples of the cations and the anions forming ionic compounds :

- GBa	tions (Metal Ions)				
Li ⁺	Lithium ion	- Ha	lides		
Na ⁺	Sodium ion	\mathbf{F}^{-}	Fluoride	O ²⁻	Oxide
K^{+}	Potassium ion	Cl ⁻	Chloride	s ²⁻	Sulphide
Ag ⁺	Silver ion	Br ⁻	Bromide	N ³ -	Nitride
Mg ²⁺	Magnesium ion	I_	Iodide	P^3	Phosphide
Ca ²⁺	Calcium ion		(This is a strength I.		
Zn^{2+}	Zinc ion	-	1	9.	•
Ba ²⁺	Barium ion	ОН	Hydroxide	ClO ₄	Perchlorate
Al ³⁺	Aluminum ion	NO_3^-	Nitrate	SO_4^{2-}	Sulphate
Fe ²⁺	Iron (II) [ferrous] ion	CH ₃ COO ⁻	Acetate	CO_3^{2}	Carbonate
Fe ³⁺	Iron (III) [ferric] ion	HCO ₃	Bicarbonate	CrO ₄ ²⁻	Chromate
Cu ⁺	Copper (I) [cuprous] ion	HSO ₄	Bisulphate	$Cr_2O_7^{2-}$	Dichromate
Cu ²⁺	Copper (II) [cupric] ion	NO_2^-	Nitrite	SO ₃ ²⁻	Sulphite
Pos	itive stomic group	MnO ₄	Permanganate	PO_4^{3-}	Phosphate
NH_4^+	Ammonium group		•		



Naming the ionic compounds

* The name of any ionic compound consists of two syllables (sections), where the name of the cation is pronounced first followed by the name of the anion.



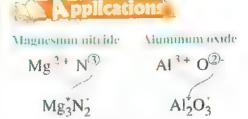
Cation Anion
Sodium chloride
Magnesium nitrate

Writing the formulas of the ionic compounds

* The symbol of the cation is being written first, followed by the symbol of the anion, the valences are exchanged, so that the total charge of the compound becomes zero.

taking into consideration

- Not to write the number which indicates the monovalence.
- Writing the atomic group between round
 brackets, then writing the valency at its bottom.
- Reducing the numbers which indicate the valences to the simplest form.



Ammonium chloride

 $NH_4^+ CI^- \Rightarrow NH_4CI$

Iron (III) sulphate

$$Fe^{3+} SO_4^{2-} \Rightarrow Fe_2(SO_4)_3$$

Copper (II) sulphate

$$Cu^{2+} SO_4^{2-} \Rightarrow CuSO_4$$

Worked Examples

Write the chemical formulas of the following manganese (Mn) oxides :

- (1) Manganese (II) oxide.
- (2) Manganese (III) oxide.
- (3) Manganese (IV) oxide (Manganese dioxide).

Answer:

$$Mn^{2+} O^{2-} \Rightarrow MnO$$

$$Mn^{2+} O^{2-} \Rightarrow MnO$$
 $Mn^{3+} O^{2-} \Rightarrow Mn_2O_3$

$$Mn^{4+} O^{2-} \Rightarrow Vin()$$

If the chemical formula of calcium pyrophosphate is $Ca_2P_2O_7$, so the chemical formula of iron (III) pyrophosphate is

(a) $\operatorname{Fe}_{2}(P_{2}O_{7})_{3}$

(b) FeP,O,

© Fe(P,O,),

(d) Fe₄ $(P_2O_7)_3$

Idea of answering:

Ca₂P₂O₇ molecule is electrically neutral, it consists of Ca²⁺ ion and P₂O₇ ion whose charge is unknown.

- : Each molecule of Ca₂P₂O₇ contains two calcium ions, the charge of each of them is +2
- \therefore The charge of the two calcium ions = $2 \times (+2) = +4$
- .. The charge of P2O7 ion must be equal numerically to that of the two calcium ions and with an opposite sign, as the molecule is neutral.
- \therefore The charge of P_2O_7 ion = $-4 \Rightarrow (P_2O_7)^{4-}$
- : The chemical formula of iron (III) pyrophosphate is:

$$Fe^{3+} P_2O_7^{4-} \Rightarrow Fe_4(P_2O_7)_3$$

Answer: The correct choice is di



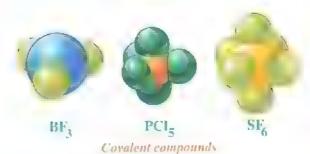
Write the chemical formulas of the following compounds:

- (1) Silver chloride.
- (2) Copper (II) nitrate.
- (3) Ammonium carbonate.

- (4) Aluminum sulphate.
- (5) Barium hydroxide.
- (6) Sodium nitrite.

- Line marine

* Covalent compounds are formed of nonmetal elements by sharing electrons without gaining or losing.



Writing the chemical formulas of the covalent compounds which are formed from two elements

* The symbol of the firstly pronounced nonmetal is being written first, followed by the symbol of the second nonmetal preceded by the prefix which indicates the number of its repetitions in the formula of the compound.

See a consistence and annual threat of	reading the second second	N. Albania			ee	
Prefix	Mono	Di	Tri	Tetra	Penta	Hexa
	*****	Send. Secondad channel	and himmand			7
Number of repetitions	1	,	3	1	5	()
	and the summer to		100 (70000000	3888		i

• The digit (1) is not being written in any formula.



Carbon monoxide	Carbon dioxide	Boron trifluoride	
CO	CO ₂	BF ₃	
Carbon tetrachloride	Phosphorus pentabromide	Sulphur hexafluoride	
CCl ₄	PBr ₅	SF ₆	

• There are some compounds which do not obey this rule, they usually have common names, such as:

Water Ammonia Phos	sphine Methane
H ₂ O NH ₃ P	PH ₃ CH ₄

Tail Voorvell

Write the chemical formulas of the following compounds:

- (1) Hydrogen iodide.
- (2) Manganese dioxide.
- (3) Sulphur trioxide.

- (4) Nitrogen trifluoride.
- (5) Sulphur tetrachloride.
- (6) Iodine heptafluoride.



Oxygenated acids and halugen acids

 All the chemical formulas of the acids are similar in that they all begin with a positive hydrogen ion, the acids can be classified into:

Oxyacids (Oxygenated acids)

Halogen acids

Naming the acids

The name starts with the name of the anion followed by the word acid, taking into consideration:

- Replacing the suffix (- ate) in the anion with the suffix (- ic).
- Replacing the suffix (- ite) in the anion with the suffix (- ous).
- The name of the anion is preceded by the word hydro.
- Replacing the suffix (- ide) with the suffix (- ic),

With exchanging the valences between the cation and the anion.

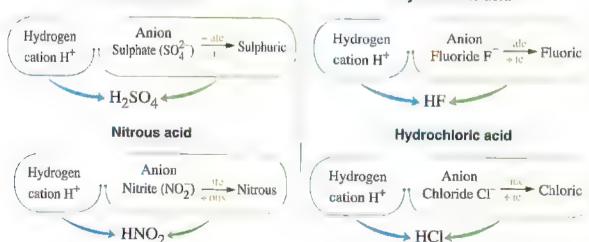
Writing the formulas of the acids

- The formula of any oxygenated acid begins with the hydrogen cation H⁺, followed by the formula of the anion (the negative atomic group), excluding the hydroxide group (OH⁻).
- The formula of any halogen acid begins with the hydrogen cation H⁺, followed by the symbol of the anion (the halide).



Sulphuric acid

Hydrofluoric acid





Write the chemical formulas of the following compounds:

(1) Nitric acid.	(2) Sulphurous acid.	(3) Perchloric acid.
***************************************	********* **************	4441554 **** ****
(4) Hydrobromic acid	(5) Hydroiodic acid.	(6) Phosphoric acid.

Worked Example

All the chemical formulas of the compounds shown in the following table are correct, except

Choices	Compound	Chemical formula		
(a)	Aluminum sulphate	$Al_2(SO_4)_3$		
Ь	Carbonic acid	H ₂ CO ₃		
©	Iron (III) bromide	Fe ₃ Br		
(d)	Phosphorus pentoxide	P_2O_5		

Idea of answering:

- : Aluminum sulphate contains Al3+ and (SO₄)2-
- ∴ The chemical formula of aluminum sulphate is $Al^{3+}SO_4^2 \Rightarrow Al_2(SO_4)_3$
- .. The choice (a) is excluded.
- ·· Carbonic acid contains H+ and (CO₃)²⁻
- ∴ The chemical formula of carbonic acid is H^+ CO_3^2 \Rightarrow H_2CO_3
- .. The choice (b) is excluded.
- : Iron (III) bromide contains Fe3+ and Br
- \therefore The chemical formula of iron (III) bromide is Fe³⁺ Br \Rightarrow FeBr₃

Answer: The correct choice is @

Quastions

2

Answered



- P³⁻ ion is known as
 - (a) phosphide ion.

b phosphorus ion.

© phosphorus (III) ion.

- (d) phosphine ion.
- Which of the following choices is not correct?

Choices	lon	Formula	
a	Sulphite	SO_3^2	
b	Phosphate	PO ₄ ³	
0	Hydride	OH -	
(1)	Nitrite	NO_2^-	

- 3 The correct name of the compound NaNO3 is
 - a trinitrogen oxide sodium.
- (b) sodium nitrate.

© sodium nitrite.

- d sodium nitride.
- (I) Ca2+ ions combine with PO₄3- ions to form a salt with the chemical formula
 - (a) CaPO_a

(b) Ca₂(PO₄)₃

Ca(PO₄)₂

- (d) Ca₃(PO₄)₂
- 5 The chemical formula of magnesium chloride is
 - (d) MgCl

(b) MgCl,

© Mg,Cl

- d Mg,Cl,
- What is the chemical formula of iron (III) nitrate?
 - (a) Fe₂(NO₃)₃

(b) Fe(NO₃)₃

© Fe₃NO₃

(d) Fe₃(NO₃)₃

7	If the chemical formula of ammonium di	chromate is $(NH_4)_2Cr_2O_7$,
	so the chemical formula of magnesium of	dichromate is
1	(i) MgCr ₂ O ₇	(b) Mg ₂ Cr ₂ O ₇
	© Mg(Cr ₂ O ₇) ₂	
8	Which of the following names of compo	unds is not correct ?
5	(II) chloride.	(b) Aluminum trioxide.
	© Magnesium oxide.	(d) Phosphorus pentoxide.
9	The correct name of LiCl is	
	(3) lithium monochloride.	b lithium (I) chloride.
	© lithium one chloride.	d lithium chloride.
1	Which of the following compounds its che	emical formula is not correct?
	(a) Ammonium bromide NH ₄ Br	
	b Potassium carbonate K2CO3	
	© Barium phosphate BaPO ₄	
	(I) Copper (I) chloride CuCl	
1	What is the formula of the compound w	hich is produced from the reaction of
	calcium metal with sulphur nonmetal?	
	(d) Ca ₃ S	(b) CaS
	© CaS ₂	(d) Ca ₃ S ₂
1	(X) is a nonmetal which reacts with alu	minum metal to form the compound AIX
	What is the name of the nonmetal (X) ?	
	(i) Oxygen.	(b) Fluorine.
	© Chlorine.	d Nitrogen.
1	The metal M hydroxide reacts with sulp	huric acid according to the equation :
	$M(OH)_{2(s)} + H_2SO_{4(aq)}$	\longrightarrow MSO _{4(aq)} + 2H ₂ O _(l)
	Which of the following elements can be	the metal M ?
	a Sodium.	(b) Magnesium.
	© Aluminum.	d Potassium.



Which of the following acids its name is not correct?

- (a) Sulphuric acid H₂SO₄
- (b) Carbonic acid H₂CO₃
- (c) Hydrochloride acid HCl
- (d) Phosphoric acid H₃PO₄



Write the chemical formulas of the following compounds.

- (1) Iron (III) hydroxide.
- (3) Lead (II) phosphate.
- (5) Potassium bicarbonate.
- (7) Sulphur dioxide.
- (9) Sodium phosphate.
- (11) Ammonium sulphate.
- (13) Carbon tetrafluoride.
- (15) Silver chromate.

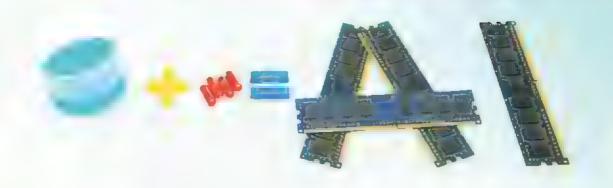
- (2) Zinc carbonate.
- (4) Ammonium nitrate.
- (6) Potassium sulphite.
- (8) Aluminum hydroxide.
- (10) Copper (II) chloride.
- (12) Hydrogen sulphide.
- (14) Barium sulphate.





from Chemical equation

Until



Chemical equation

The chemical reaction is represented by a symbolic chemical equation, which is:

A group of chemical symbols and formulas of the reactants and the products, which are connected by an arrow that determines the direction of the reaction and above which the reaction conditions are written.

• The following table represents signs which are included in any chemical equation and their indications:

Sign	Indication	Application		
+	Separates each two reactants or products	Mg + CuSO ₄ MgSO ₄ + Cu		
→	An arrow separates the reactants from the products in the reactions (which proceed in only one direction)	Reactants		
	An arrow that separates the reactants from the products in the reversible reactions (which proceed in both directions forward and backward)	$N_2 + O_2 \longrightarrow 2NO$		

In the lower right-hand corner of the element symbol or the chemical formula, certain symbols are written to in licate need to remphysical tates of each reactant and product, illustrated in the following table:

Symbol	(s)	(t)	(g)	(aq)	(v)
Indication (Physical state)	Solid	1 iquid	Gas	Aqueous solution (Substance dissolved in water)	Vapour (solid or liquid vapourized by heat)
Examples	Mg \ AgCl_\	H ₂ O _()	O _{2,g} CO _{2,g} ,	H ₂ SO _{4(1c₁)} NaCl _(1c)	I ₂₍₁₎ H ₂ O ₁₎

• On the arrow which determines the reaction direction, reaction conditions are written (if there are conditions), as those which are shown in the following table:

Sign	Δ	P	Symbols of some elements as : Fe , Ni
Indication	Heat	Pressure	Catalysts to accelerate the reaction
Application		N _{2(g)}	$+3H_{2(g)} \xrightarrow{\Delta/P} 2NH_{3(g)}$

Worked Example

Sulphur reacts with nitric acid according to the equation:

$$S + 6HNO_3 \longrightarrow H_2SO_4 + 6NO_2 + 2H_2O$$

Which of the following represents the physical states of some reactants and products?

(a)
$$H_2SO_{4(t)}$$
, $S_{(g)}$

$$\textcircled{b}$$
 $\text{H}_2\text{O}_{(l)}$, $\text{HNO}_{3(aq)}$

$$\textcircled{d} \ \textbf{H}_2\textbf{SO}_{4(\textbf{aq})} \ \ , \ \ \textbf{NO}_{2(t)}$$

Idea of answering:

- : Sulphur S exists in the solid form (s) under normal conditions.
- .. The choice (a) is excluded.
- ∴ Nitric acid exists in its aqueous form (aq) or liquid form (\(\ell\)), but it does not exist as a gas (g).
- : The choice (c) is excluded.
- : Nitrogen dioxide exists in its gaseous form (g).
- : The choice (d) is excluded.

Answer: The correct choice is b

Balanced chemical equations

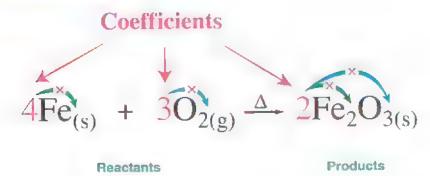
• The balanced chemical equation represents the ratios of the definite amounts by which the reactants react together to form the products.

In the balanced equation it is considered that:

Number of atoms of each element in the reactants equals the number of its atoms in the products to verily the law of conservation of matter.

This is fulfilled by writing numbers preceding the symbols of **the elements** and **the chemical formulas** of the compounds known as **the coefficients**, they represent the simplest ratio by which the reactants react together to form the products.





$${}^{2}C_{2}H_{6(g)} + {}^{7}O_{2(g)} \xrightarrow{\Delta} {}^{4}CO_{2(g)} + {}^{6}H_{2}O_{(v)}$$

Reactants

Products

It is obvious in the previous balanced equation that each 2 units of C2H6 require 7 units of O₂ to be burnt completely,

to calculate the number of units of O_2 required to burn only one unit of C_2H_6 , the whole equation is being divided by 2, it is written as follows:

$$C_2H_{6(g)} + \frac{7}{2}O_{2(g)} \xrightarrow{\Delta} 2CO_{2(g)} + 3H_2O_{(v)}$$

Reactants

Products

2 The coefficient (1) is not written in the balanced chemical equations.

Ventication |



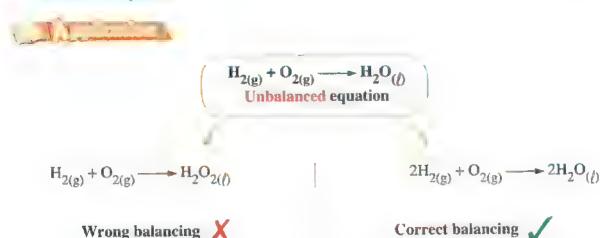
Reactants

Pb	0	H	N
3	4 + 12 = 16	4	4

Products



● The chemical formula of any of the reactants or the products is not changed to balance the equation.



Despite that the number of the elements atoms are equal in both the reactants and the products, because the chemical formula of water (the product) is changed

Wrong balancing X

As the coefficients are changed to keep the number of elements atoms equal in both the reactants and the products without changing any chemical formula

Worked Examples

Which of the following represents the balanced equation of the reaction of aluminum with oxygen?

(a)
$$2AI_{(s)} + 3O_{2(g)}$$
 (b) $AI_{(s)} + O_{2(g)}$ (c) $3AI_{(s)} + O_{2(g)}$ (d) $4AI_{(s)} + 3O_{2(g)}$ (d) $4AI_{(s)} + 3O_{2(g)}$ (e) $2AI_2O_{3(s)}$

Idea of answering:

- : Numbers of oxygen O atoms are not equal in both the reactants and the products.
- ... The choice (a) is excluded.
- : Numbers of each of aluminum Al and oxygen O are equal in both the reactants and the products, but the chemical formulas of the reactants and the products must not be changed upon balancing the chemical equation, where aluminum reacts with oxygen yielding aluminum oxide Al_2O_3 , not AlO_2 or Al_3O_2
- ... The choices (b) and (c) are excluded.

Answer: The correct choice is (d)

Idea of answering:

1 Writing the initial (primary) equation, and checking if it is balanced.

$$N_{2(g)}$$
 + $H_{2(g)}$ \longrightarrow $NH_{3(g)}$

Reactants Products

 N H N H H 2 | 2 | 1 | 3 X | X | X | X

The equation is unbalanced as the numbers of both N and H atoms are not equal in the reactants and in the products.

2 Balancing the atoms of nitrogen by multiplying the coefficient of $NH_3 \times 2$

The equation is still unbalanced, as the number of H atoms is not equal in the reactants and in the products.

3 Balancing the atoms of hydrogen by multiplying the coefficient of $H_2 \times 3$

The equation is now balanced as the numbers of atoms of N and H are equal in both reactants and products.

Answer:

$$N_{2(g)} + 3H_{2(g)} - 2NH_{3(g)}$$

Which of the following equations verifies the law of conservation of matter?

(b)
$$2H_2 + O_2 \longrightarrow H_2O$$

(d)
$$4P + 5O_2 \longrightarrow 2P_2O_5$$

Idea of answering:

The law of conservation of matter is being verified in the chemical equation when the number of the atoms of each element in the reactants equals their number in the products.

- : In the equation (a), the number of the atoms of each of H and Cl in the reactants does not equal their number in the products.
- :. The choice (a) is excluded.
- : In the equation (b), the number of the atoms of each of H and O in the reactants does not equal their number in the products.
- .. The choice (b) is excluded.
- . Sodium exists as a monatomic molecule in the normal conditions.
- : The choice © is excluded.
- : In the equation (d), the number of the atoms of each of P and O in the reactants equals their number in the products.
- : Equation (d) verifies the law of conservation of matter.

Answer: The correct choice is (d



Rewrite the following word equation in the form of a balanced symbolic equation, with writing the physical state of each of the reactants and the products:

Sodium chloride solution + Silver nitrate solution -----

	Sodium nitrate solu	ition + Silve	er chloride salt
 		*	

The following equation is not balanced: $K_3PO_4 + Ca(NO_3)_2 \longrightarrow Ca_3(PO_4)_2 + KNO_3$ Which of the following represents the correct balanced equation?

(a)
$$K_6P_2O_8 + Ca_3N_6O_{18} \longrightarrow Ca_3P_2O_8 + K_6N_6O_{18}$$

(b)
$$K_3PO_4 + Ca(NO_3)_2$$
 → $Ca_3(PO_4)_2 + 3KNO_3$

©
$$2K_3PO_4 + Ca(NO_3)_2 \longrightarrow Ca_3(PO_4)_2 + 6KNO_3$$

(d)
$$2K_3PO_4 + 3Ca(NO_3)_2 \longrightarrow Ca_3(PO_4)_2 + 6KNO_3$$

Idea of answering:

By comparing the numbers of atoms of each element in both sides of each equation in these 4 choices, it is found that equation (d) is balanced.

Reactants

K	P	0	Ca	N
6	2	26	3	6
1	1	1	1	1

Products

K	Р	O	Ca	N
6	2	26	3	6
1	1	1	1	1

Answer: The correct choice is (d)

In a chemical reaction, an oxygen atom combines with two potassium atoms forming K₂O compound.

Conclude the coefficient of oxygen in the balanced symbolic equation of the reaction.

Idea of answering:

- 1 Initial unbalanced equation: $K_{(s)} + O_{2(g)} \longrightarrow K_2O_{(s)}$
- **2** Balancing potassium: $2K_{(s)} + O_{2(g)} \longrightarrow K_2O_{(s)}$
- Balancing oxygen: $2K_{(s)} + O_{2(g)} \longrightarrow 2K_2O_{(s)}$
- Rebalancing potassium: $4K_{(s)} + O_{2(g)} \longrightarrow 2K_2O_{(s)}$

Answer: The coefficient of oxygen in the balanced equation ⇒ 1

Test Vourself

The following equation is unbalanced:

$$Mg_3N_{2(s)} + H_2SO_{4(aq)} \longrightarrow MgSO_{4(aq)} + (NH_4)_2SO_{4(aq)}$$

What is the value of the coefficient of sulphuric acid after balancing the equation?

(a) 1

(b) 3

(c) 4

(d) 7

Answer: The correct choice is



The equation of burning (the combaction of) the beginning compound

The organic compounds which are composed of:

The two elements (C and H) are known

The elements (C, H and O) such as:

as hydrocarbons, such as:

Or Methanol CH₃OH

Methane CH_4 . Propylene C_3H_6

Acetic acid CH₃COOH

On complete burning with oxygen, they give carbon dioxide gas and water vapour (or liquid water) according to the reaction conditions



The equation of burning glucose C6H12O6

$$C_6H_{12}O_{6(s)} + 6O_{2(g)} \xrightarrow{\Delta} 6CO_{2(g)} + 6H_2O_{(v)}$$

Worked Example

Write the balanced symbolic equation which represents the reaction of the complete burning of acetaldehyde liquid CH₃CHO

Idea of answering:

1 Writing the initial symbolic equation with checking if it is balanced.

$$\mathrm{CH_3CHO}_{(l)} + \mathrm{O}_{2(g)} \xrightarrow{\quad \Delta \quad} \mathrm{CO}_{2(g)} + \mathrm{H_2O}_{(v)}$$

Reactants

Products

The equation is unbalanced.

2 Balancing carbon atoms by multiplying CO₂ coefficient × 2 and balancing sydrogen atoms by multiplying H₂O coefficient × 2

$$\text{CH}_{3}\text{CHO}_{(l)} + \text{O}_{2(g)} \xrightarrow{\Delta} 2\text{CO}_{2(g)} + 2\text{H}_{2}\text{O}_{(v)}$$

Reactants

Products

C	Н	0
2	4	3
1	1	Ж

C	Н	0
2	4	6
1	1	Х

The equation is still unbalanced.

3 : Number of oxygen atoms in the products is 6 and in acetaldehyde is 1

 \therefore Balancing oxygen atoms by multiplying O_2 coefficient $\times \frac{5}{5}$

$$CH_3CHO_{(l)} + \frac{5}{2}O_{2(g)} \xrightarrow{\Delta} 2CO_{2(g)} + 2H_2O_{(v)}$$

Reactants

C	Н	O
2	4	6
1	1	1

Products

C	Н	0
2	4	6
1	1	1

The equation is now balanced.

But the fraction coefficient of oxygen $(\frac{5}{2})$ must be simplified by multiplying all the coefficients $\times 2$

Answer: $2CH_3CHO_{(l)} + 5O_{2(g)} \xrightarrow{\Delta} 4CO_{2(g)} + 4H_2O_{(v)}$

N Test Vourseit

What is the coefficient of propene C_3H_6 in the balanced symbolic equation which represents its complete burning with oxygen ?

- (a) 2
- (b) 6

© 7

(d) 9

Idea of answering:

∵ Propene is an organic compound which burns with oxygen forming CO₂ gas and water vapour.

... This reaction is represented by the following equation:

$$C_3H_{6(g)} + \cdots O_{2(g)} \xrightarrow{\Delta} \cdots O_{(v)}$$

By multiplying the coefficients $\times \cdot \cdot \cdot$ to simplify the fraction.

$$C_3H_{6(g)} + \cdots + C_{2(g)} \xrightarrow{\Delta} \cdots + \cdots + C_{(v)}$$

Answer: The correct choice is

lonic equation

- Ionic equations can be used to represent some.
 - (1) Physical processes, such as:

Dissociation of the molecules of some ionic substances when they are:

- Thermally decomposed.
- Dissolved in water.



Dissolution of sodium chloride in water



The ionic equation which represents dissolving sodium chloride salt in water:

- (2) Chemical reactions, such as:
 - Neutralization reactions
- **B** Precipitation reactions
- * Before studying the ionic equations, it is necessary to know:
 - The most famous acids and bases which ionize (dissociate) completely in water:

The most famous acids which lonize completely in water

Hydrochloric acid.

$$HCl_{(g)} \xrightarrow{\text{water}} H^+_{(aq)} + Cl^-_{(aq)}$$

· Nitric acid.

$$HNO_{3(\ell)} \xrightarrow{water} H^+_{(ac)} + NO^+_{3(aq)}$$

· Sulphuric acid.

$$H_2SO_{4(l)} \xrightarrow{\text{water}} 2H_{(aq)}^r + SO_{4(aq)}^2$$

The most famous bases which ionize completely in water

• Potassium hydroxide.

$$KOH_{(s)} \xrightarrow{water} K_{(aq)}^+ + OH_{(aq)}$$

• Sodium hydroxide.

NaOH_(s)
$$\xrightarrow{\text{water}}$$
 Na⁺_(aq) + OH⁻_(aq)

• Barium hydroxide.

$$Ba(OH)_{2(s)} \xrightarrow{water} Ba_{(aq)}^{2+} + 2OH_{(aq)}$$

2 The most famous salts that dissolve in water and those which do not dissolve in water:

The most famous salts which dissolve in water	The most famous salts which do not dissolve in water
All nitrate salts dissolve in water. KNO _{3(s)} water K ⁺ _(aq) + NO _{3(aq)}	• All phosphate salts do not dissolve in water, except: Na ₃ PO _{4(s)} , K ₃ PO _{4(s)} , (NH ₄) ₃ PO _{4(s)}
All bicarbonate salts dissolve in water. NaHCO _{3(s)} $\xrightarrow{\text{water}}$ Na $^+_{(aq)}$ + HCO $^{3(aq)}$	• All carbonate salts do not dissolve in water, except: Na ₂ CO _{3(s)} , K ₂ CO _{3(s)} , (NH ₄) ₂ CO _{3(s)}
All sulphate salts dissolve in water, except: $ Ag_2SO_{4(s)} , $	• All sulphite salts do not dissolve in water, except: Na ₂ SO ₃₍₈₎
$BaSO_{4(s)}$, $PbSO_{4(s)}$	$K_2SO_{3(s)}$, $(NH_4)_2SO_{3(s)}$,
All chloride salts dissolve in water,	All solid hydroxides do not dissolve
$\begin{array}{ccc} \underline{\text{CuCl}_{(s)}} & , & \text{PbCl}_{2(s)} \\ \underline{\text{AgCl}_{(s)}} & & & & & & & & & & & & & & & & & & $	in water, except: $ \begin{array}{cccc} \text{KOH}_{(s)} & , & \text{NaOH}_{(s)} \\ \text{NH}_4\text{OH}_{(s)} & , & \text{Ba(OH)}_{2(s)} \\ \end{array} $ (The degree of solubility of Ca(OH), is low



Ionic equation which represents a neutralization reaction

Steps of writing the ionic equation which represents neutralization reactions

- (1) Writing the balanced symbolic equation of the chemical reaction.
- (2) Writing the reactants and the products in the form of ions, taking into consideration that water is a principal product and found in the form of molecules in the liquid state.
- (3) The ions which did not participate in the reaction are cancelled from both sides of the equation.
- (4) Reducing the coefficients to the simplest form -when possibleto write the equation which shows only the reacting ions.

pplication (Reaction of

sulphuric acid with sodium hydroxide solution to produce sodium sulphate and water)

$$H_2SO_{4(aq)} + 2NaOH_{(aq)} \longrightarrow$$

$$Na_2SO_{4(aq)} + 2H_2O_{(f)}$$

$$2H_{(aq)}^{+} + SO_{4(aq)}^{2-} + 2Na_{(aq)}^{+} + 2OH_{(aq)}^{-}$$
 $2Na_{(aq)}^{+} + SO_{4(aq)}^{2-} + 2H_{2}O_{(l)}$

For Illustration



Cancelled ions are called spectator ions

$$2H_{(aq)}^{+} + 2OH_{(aq)}^{-} \longrightarrow 2H_{2}O_{(\ell)}$$

$$H_{(aq)}^{+} + OH_{(aq)}^{-} \longrightarrow H_{2}O_{(\ell)}$$

(This equation represents what is known as the net ionic equation for all neutralization reactions whatever the types of the strong acid and base are)

Worked Examples

1 The following 5 incomplete equations represent neutralization reactions of acids with bases in aqueous solutions:

$$(2)$$
 HNO₃ + Mg(OH)₂

$$HNO_3 + Mg(OH)_2$$
 ——

(3)
$$H_3PO_4 + Ba(OH)_2$$

What is (are) the reaction(s) which is (are) represented by the ionic equation:

$$H^+ + OH^- \longrightarrow H_2O$$
?

Idea of answering:

- ∴ NH₄OH is a weak incompletely ionized base, H₃PO₄ and H₂CO₃ are weak incompletely ionized acids.
- : The choices (a), (b) and (c) are excluded.

Answer: The correct choice is (d)

What is the net ionic equation which represents the reaction of acetic acid solution with potassium hydroxide solution?

(a)
$$CH_3COOH_{(aq)} + KOH_{(aq)} \longrightarrow CH_3COOK_{(aq)} + H_{(aq)}^+ + OH_{(aq)}^-$$

(b)
$$H_{(aq)}^+ + OH_{(aq)}^- \longrightarrow H_2O_{(\ell)}$$

©
$$CH_3COOH_{(aq)} + OH_{(aq)}^- \longrightarrow CH_3COO_{(aq)}^- + H_2O_{(t)}$$

$$\bigcirc$$
 CH₃COO⁻_(aq) + KOH_(aq) \longrightarrow CH₃COOK_(aq) + H₂O_(l)

Idea of answering:

- : Potassium hydroxide KOH is a strong completely ionized base.
- : The choices (a) and (d) are excluded.
- : Acetic acid CH3COOH is a weak incompletely ionized acid.
- : The choice (b) is excluded.

Answer: The correct choice is (c



Ionic equation which represents a precepitation reaction

Steps of writing the ionic equation which represents precipitation reactions

- (1) Writing the balanced symbolic equation of the chemical reaction.
- (2) Writing the reactants and the products in the form of ions, considering that the formed precipitate is insoluble in water and found in the solid state.
- (3) The ions which did not participate in the reaction are cancelled from both sides of the equation.
- (4) Writing the equation which shows only the reacting ions.

ilver nitrate solution with potassium chromate solution to form a red precipitate of silver chromate

$$2AgNO_{3(aq)} + K_2CrO_{4(aq)} \longrightarrow$$

 $2KNO_{3(aq)} + Ag_2CrO_{4(s)}$

1
2Ag $_{(aq)}^{+}$ + 2NO $_{3(aq)}^{-}$ + 2K $_{(aq)}^{+}$ + CrO $_{4(aq)}^{2-}$ - 2 2K $_{(aq)}^{+}$ + 2NO $_{3(aq)}$ + Ag $_{2}$ CrO $_{4(s)}$

$$2Ag_{(aq)}^{+} + CrO_{4(aq)}^{2} \longrightarrow Ag_{2}CrO_{4(s)}$$

The ionic equation of precipitation reactions differs from one reaction to another

It is noticed in the ionic equations of the neutralization reactions and the precipitation reactions that:

- The summation of the positive charges equals the summation of the negative charges in each of the two sides of the equation.
- The number of atoms (ions) of the elements entering the reaction equals the number of those which are produced from the reaction.

Worked Exemples

(1) What is the net ionic equation which represents the reaction of calcium nitrate solution with sodium carbonate solution?

(a)
$$Ca_{(aq)}^{2+} + CO_{3(aq)}^{2-} \longrightarrow CaCO_{3(s)}$$

(b)
$$Na_{(aq)}^+ + NO_{3(aq)}^- \longrightarrow NaNO_{3(s)}$$

$$\bigcirc$$
 Ca(NO₃)_{2(aq)} + Na₂CO_{3(aq)} \longrightarrow 2NaNO_{3(s)} + CaCO_{3(s)}

$$\textcircled{d} \operatorname{Ca(NO_3)_{2(aq)}} + \operatorname{Na_2CO_{3(aq)}} \longrightarrow 2\operatorname{NaNO_{3(aq)}} + \operatorname{CaCO_{3(s)}}$$

Idea of answering:

Calcium nitrate solution reacts with sodium carbonate solution according to the equation :

$$Ca(NO_3)_{2(aq)} + Na_2CO_{3(aq)} \longrightarrow 2NaNO_{3(aq)} + CaCO_{3(s)}$$

This reaction is represented by the following complete ionic equation

$$Ca_{(aq)}^{2+} + 2NO_{3(aq)} + 2Na_{(aq)}^{+} + CO_{3(aq)}^{2-} \longrightarrow 2Na_{(aq)}^{+} + 2NO_{3(aq)} + CaCO_{3(s)}$$

The net ionic equation after cancelling the spectator ions is

$$Ca_{(aq)}^{2+} + CO_{3(aq)}^{2} \longrightarrow CaCO_{3(s)}$$

Answer: The correct choice is (a

What is the net ionic equation which represents the reaction of nitric acid solution with aluminum hydroxide?

(a)
$$3H_{(aq)}^+ + Al(OH)_{3(s)} \longrightarrow Al_{(aq)}^{3+} + 3H_2O_{(l)}$$

(b)
$$3HNO_{3(aq)} + Al(OH)_{3(s)} \longrightarrow Al(NO_3)_{3(aq)} + 3H_2O_{(/)}$$

©
$$HNO_{3(aq)} + OH_{(aq)}^{-} \longrightarrow NO_{3(aq)}^{-} + H_2O_{(/)}$$

$$(d) H_{(aq)}^+ + OH_{(aq)}^- \longrightarrow H_2O_{(\ell)}$$

Idea of answering:

- Aluminum hydroxide does not dissolve in water (does not ionize giving OH_(aq) ions).
- .. The choices (c) and (d) are excluded.
- · Nitric acid is a strong acid which ionizes in water giving H⁺_(ao) ions.
- ... The choice (b) is excluded.

Answer: The correct choice is: (a

What is the ionic equation which represents the formation of magnesium carbonate salt from the reaction of MgCl, and Na,CO, solutions?

(a)
$$Mg_{(aq)}^{2+} + CO_{3(aq)}^{2-} \longrightarrow MgCO_{3(aq)}$$

(b)
$$Na_2CO_{3(aq)} + MgCI_{2(aq)} \longrightarrow 2Na_{(aq)}^+ + 2CI_{(aq)}^- + MgCO_{3(s)}$$

©
$$Mg_{(aq)}^{2+} + CO_{3(aq)}^{2-} \longrightarrow MgCO_{3(s)}$$

(d)
$$Na_2CO_{3(aq)} + MgCl_{2(aq)} \longrightarrow 2NaCl_{(aq)} + Mg^{2+}_{(s)} + CO^{2-}_{3(s)}$$

Idea of answering :

- MgCl₂ salt and Na₂CO₃ salt both found in solutions in the form of ions, while magnesium carbonate salt is insoluble in water.
- ... This reaction can be represented by the following symbolic equation:

$$MgCl_{2(aq)} + Na_2CO_{3(aq)} \longrightarrow 2NaCl_{(aq)} + MgCO_{3(s)}$$

And it is represented by the following complete ionic equation:

$$Mg_{(aq)}^{2+} + 2Cl_{(aq)}^{-} + 2Na_{(aq)}^{+} + CO_{3(aq)}^{2-} \longrightarrow 2Na_{(aq)}^{+} + 2Cl_{(aq)}^{-} + MgCO_{3(s)}$$

The net ionic equation after cancelling the spectator ions is:

$$Mg_{(aq)}^{2+} + CO_{3(aq)}^{2-} \longrightarrow MgCO_{3(s)}$$

Answer: The correct choice is (c)



Answer them yourself

Choose the correct answer:

(1) The abbreviation (g)	is written down	the right	of the	chemical	formula (οť
the compound in its .						

- a. solid state. b. liquid state. c. gaseous state.
- (2) What is the abbreviation which is written down the right of the chemical formula of sodium hydroxide aqueous solution?
 - a.s b.l c.aq d.g
- (3) The chemical equation must be balanced to verify the law of . .
- a. Avogadro. b. energy conservation.
 - e mass conservation, d. fixed ratios.
- (4) What is the equation which expresses correctly the physical states of both reactants and products in the reaction of magnesium combustion?

a.
$$2Mg_{(s)} + O_{2(l)} \xrightarrow{\Delta} 2MgO_{(g)}$$
 b. $2Mg_{(s)} + O_{2(g)} \xrightarrow{\Delta} 2MgO_{(l)}$

c,
$$2Mg_{(s)} + O_{2(g)} \xrightarrow{\Delta} 2MgO_{(s)}$$
 d. $2Mg_{(s)} + O_{2(g)} \xrightarrow{\Delta} 2MgO_{(g)}$

(5) Which of the following represents the ionic equation of a precipitation process?

a.
$$\operatorname{NaCl}_{(s)} \longrightarrow \operatorname{Na}_{(l)}^+ + \operatorname{Cl}_{(l)}^-$$

b. $\operatorname{NaCl}_{(s)} \longrightarrow \operatorname{Na}_{(aq)}^+ + \operatorname{Cl}_{(aq)}^-$
$$\operatorname{H}_{(aq)}^+ + \operatorname{OH}_{(aq)}^- \longrightarrow \operatorname{H}_2\operatorname{O}_{(l)}$$

d. $\operatorname{Ag}_{(aq)}^+ + \operatorname{Cl}_{(aq)}^- \longrightarrow \operatorname{AgCl}_{(s)}$

(6) What are the ions which did not change in the following equation?

$$Fe_{(s)} + CuSO_{4(aq)} \longrightarrow FeSO_{4(aq)} + Cu_{(s)}$$

$$d. SO_{4(aq)}^{2} \qquad b. Cu_{(s)}, SO_{4(aq)}^{2}$$

$$c. Fe_{(s)}, SO_{4(aq)}^{2-} \qquad d. Fe_{(s)}, Cu_{(s)}$$



Rewrite the following chemical equations after balancing each one:

(1)
$$N_{2(g)} + H_{2(g)} \longrightarrow NH_{3(g)}$$

(2)
$$H_2SO_{4(aq)} + KOH_{(aq)} \longrightarrow K_2SO_{4(aq)} + H_2O_{(l)}$$

(3)
$$Al_{(s)} + O_{2(g)} \xrightarrow{\Delta} Al_2 O_{3(s)}$$

(4)
$$Cu(NO_3)_{2(s)} \xrightarrow{\Delta} CuO_{(s)} + NO_{2(g)} + O_{2(g)}$$

- Write balanced symbolic equations to represent the following reactions, indicating the physical states of both reactants and products:
 - (1) Iron + Chlorine gas Fron (III) chloride salt
 - (2) The reaction of barium chloride solution with magnesium sulphate solution to from magnesium chloride solution and barium sulphate salt.

Write the balanced ionic equations to represent the following reactions:

- (1) The dissolution of magnesium chloride salt in water.
- (2) Nitric acid + Potassium hydroxide solution ----- Potassium nitrate solution + Water
- (3) The neutralization of sulphuric acid with barium hydroxide.
- (4) The reaction of silver nitrate and sodium chloride solutions to form sodium nitrate solution and silver chloride precipitate.



Open book questions

: Answered





Balanced chemical equations

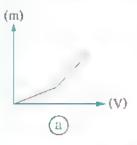
1 __ On adding drops of NaOH solution to AICl, solution,

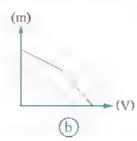
this reaction occurs: $AlCl_{3(aq)} + 3NaOH_{(aq)} \longrightarrow 3NaCl_{(aq)} + Al(OH)_{3(s)}$

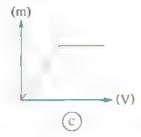
, and when more NaOH solution is added to the reaction container.

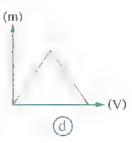
this reaction occurs : $Al(OH)_{3(s)} + NaOH_{(aq)} \longrightarrow NaAlO_{2(aq)} + 2H_2O_{(l)}$

Which of the following graphical figures represents the relation between the mass of the formed precipitate (m) and the added volume of NaOH solution (V)?









What is the equation which does not verify the law of conservation of mass?

(a)
$$4AI + 3O_2 \xrightarrow{\Delta} 2AI_2O_3$$

ⓑ
$$C_2H_6 + \frac{7}{2}O_2 \xrightarrow{\Delta} 2CO_2 + 3H_2O$$

©
$$2KClO_3 \xrightarrow{\Delta} 2KCl + \frac{3}{2}O_2$$

(d)
$$4P_4 + 5S_8 \xrightarrow{\Delta} 4P_4S_{10}$$

- 1 This chemical equation is unbalanced: $As(OH)_3 + H_2SO_4 \longrightarrow As_2(SO_4)_3 + H_2O_4$ What is the coefficient of water after balancing the equation?
 - (a) 2

(b) 4

(c) 6

- (d) 8
- The solid indium element reacts with chlorine gas forming InCl₃

 What is the coefficient of InCl₃ in the balanced equation of the reaction?
 - (a) i

(b) 2

© 3

d 4



In the equation : $xP_4O_6 + H_2O \longrightarrow yH_3PO_3$ What is the value of the coefficient (y) when (x) = 2? by this mark (a) 2 (e) 6 Sodium carbonate salt reacts with hydrochloric acid to form sodium chloride, carbon dioxide and water respectively. What is the correct order of the coefficients of these substances in the balanced symbolic equation respectively? (b) 8, 6, 5, 10, 5 (a) 3, 6, 6, 3, 4 © 5, 10, 10, 5, 5 (d) 1, 2, 2, 1, 1 What is the summation of the coefficients in this equation after balancing? $NaNH_2 + NaNO_3 \longrightarrow NaN_3 + NaOH + NH_3$ (a) 9 incorporate of branches, the containing of the reserve on, have ${f 89}$ The compound ${f C_4 H_8 O_2}$ burns completely in ${f O_2}$ gas forming carbon dioxide gas and water vapour. What is the coefficient of oxygen in the balanced equation of the combustion (burning) reaction? (a) 3 (0) 5 **9** What is the coefficient of methanol CH_3OH_{th} in the balanced equation of its complete combustion with oxygen? (a) 3/2 (c) 3 10 \sum The organic compounds burn yielding $CO_{2(g)}$ and $H_2O_{(y)}$ Which of the following compounds requires 3 mol of oxygen for the complete burning of 1 mol of it? (a) CH₂CHO (b) C₂H₅OH (d) CH₃COOH (C) C,H6

Ionic equation

in terms of these equations:

(1)
$$NaCl_{(s)} \xrightarrow{\Delta} Na_{(l)}^+ + Cl_{(l)}^-$$

(2)
$$NaCl_{(s)} \xrightarrow{water} Na^+_{(aq)} + Cl^-_{(aq)}$$

Which of the following represents the two processes (1) and (2)?

Choices	Process (1)	Process (2)
a	Neutralization	Precipitation
b	Melting	Dissolution
0	Dissolution	Melting
(1)	Precipitation	Neutralization

Drops of sodium hydroxide are added to an amount of water in a tube.

Which of the following does not exist in the tube?

(a) OH-

(b) Na⁺

(c) NaOH

(d) Na+, OH-

lonic equation which represents a neutralization reaction

- What are the ions which are not written in the net ionic equation of the reaction of potassium hydroxide solution with hydrochloric acid?
 - (a) K+, H+

(b) H+, OH-

(c) K+, Cl⁻

(d) H+, CI

Ionic equation which represents a precipitation reaction

Copper (II) sulphate solution reacts with sodium hydroxide solution forming a blue precipitate of copper (II) hydroxide.

Which of the following equations represents the net ionic equation of this reaction?

(a)
$$Cu_{(aq)}^{2+} + OH_{(aq)}^{-} \longrightarrow Cu(OH)_{2(s)}$$

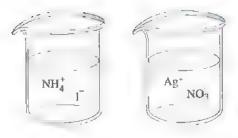
(b)
$$Cu_{(aq)}^{2+} + 2OH_{(aq)}^{-} \longrightarrow Cu(OH)_{2(s)}$$

$$\bigcirc$$
 Cu⁺_(aq) + 2OH⁻_(aq) \longrightarrow Cu(OH)_(s)

$$\bigcirc$$
 Cu(2+ 2OH_(aq) \longrightarrow Cu(OH)_{2(s)}

The opposite figures show two beakers containing two different aqueous solutions.

Which of the following equations is the net ionic equation which represents the reaction occurring between them?



$$\textcircled{b}$$
 $Ag^+_{(aq)} + I^-_{(aq)} \longrightarrow AgI_{(s)}$

$$\bigcirc$$
 NH₄(aq) + NO_{3(aq)} \longrightarrow NH₄NO_{3(s)}

d
$$NH_{4(aq)}^{+} + NO_{3(aq)}^{-} \longrightarrow NH_{4}NO_{3(aq)}$$

The following equation represents the reactants in one of the chemical reactions,

$$2Na_{(aq)}^{+} + SO_{4(aq)}^{2-} + Ba_{(aq)}^{2+} + 2Cl_{(aq)}^{-} \longrightarrow$$

What are the products of the net ionic equation which represents this reaction?

(a)
$$BaSO_{4(s)} + 2Na_{(aq)}^{+} + 2Cl_{(aq)}^{-}$$



Balanced chemical equations

17 Balance the following equations:

(1)
$$KNO_3 \xrightarrow{\Delta} KNO_2 + O_2$$

(2) Na +
$$H_2O \longrightarrow NaOH + H_2$$

(3)
$$\operatorname{Fe_3O_4} + \operatorname{H_2} \longrightarrow \operatorname{Fe+} \operatorname{H_2O}$$

(4)
$$MnO_2 + HCl \longrightarrow H_2O + MnCl_2 + Cl_2$$

(5)
$$Pb(NO_3)_2 \xrightarrow{\Delta} PbO + NO_2 + O_2$$

(6)
$$C_2H_5OH + O_2 \xrightarrow{\Delta} CO_2 + H_2O$$



(18) Complete the following equations with what is suitable, with balancing them:

(1)
$$HNO_3 + Al(OH)_3 \longrightarrow \dots$$

(3) KF +
$$Sr(NO_3)_2 \longrightarrow$$

Write the balanced symbolic equations which represent the following reactions. with writing the physical states of both the reactants and the products:

- (1) Reaction of iron (III) oxide powder with carbon monoxide gas to form iron and carbon dioxide.
- (2) Reaction of propane gas C₃H₈ with oxygen to form carbon dioxide gas and water vapour.
- (3) Reaction of calcium phosphate salt with aqueous solution of sulphuric acid to form a precipitate of calcium sulphate and aqueous solution of phosphoric acid.

Potassium can react with oxygen gas forming three different solid oxides, according to the reacting amount of each of oxygen gas and potassium, as follows:

· The first oxide:

In which each two atoms of potassium combine with one atom of oxygen.

• The second oxide :

In which each two atoms of potassium combine with two atoms of oxygen.

· The third oxide:

In which each one atom of potassium combines with two atoms of oxygen.

Deduce the coefficient of potassium in each of the three symbolic equations which represent the formation of these three oxides of potassium with oxygen gas.

Ionic equation which represents a precipitation reaction

Barrum sulphate salt can be precipitated by carrying out a reaction between an acid and a base:

- (1) Write the balanced symbolic equation which represents this reaction.
- (2) Write the net ionic equation of this reaction.

On mixing two solutions in a beaker, the illustrated substances in the opposite figure are formed:

- (1) Write the balanced symbolic equation which represents the reaction.
- (2) Write the net ionic equation of this reaction.



Choosing two out of five choices questions :

(a)
$$4Al + 3O_2 \longrightarrow 2Al_2O_3$$

(b)
$$C_2H_6 + \frac{7}{2}O_2 \longrightarrow 2CO_2 + 3H_2O$$

©
$$2KClO_3 \longrightarrow 2KCl + \frac{3}{2}O_2$$

(d)
$$4P_4 + 5S_8 \longrightarrow 4P_4S_{10}$$

(e)
$$As(OH)_3 + 3H_2SO_4 \longrightarrow As_2(SO_4)_3 + 6H_2O$$

2 What are the reactions which can be represented

by the following ionic equation :
$$H_{(aq)}^+ + OH_{(aq)}^- \longrightarrow H_2O_{(\ell)}$$
?

(a)
$$CH_3COOH_{(aq)} + KOH_{(aq)} \longrightarrow CH_3COOK_{(aq)} + H_2O_{(l)}$$

(b)
$$HCl_{(aq)} + NaOH_{(aq)} \longrightarrow NaCl_{(aq)} + H_2O_{(l)}$$

©
$$H_2CO_{3(aq)} + Mg(OH)_{2(aq)} \longrightarrow MgCO_{3(s)} + 2H_2O_{(l)}$$

$$(d)$$
 $HCl_{(aq)} + NH_4OH_{(aq)} \longrightarrow NH_4Cl_{(aq)} + H_2O_{(l)}$

(e)
$$H_2SO_{4(aq)} + 2KOH_{(aq)} \longrightarrow K_2SO_{4(aq)} + 2H_2O_{(l)}$$



Lesson 2

From



The building unit of the substance differs according to the join in which the substance exists, as shown in the following scheme:

The building unit or the substance in ay be

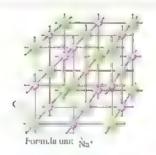
•		•
Atom	Formula unit	Molecule
Element	Ionic compound	Covalent compound
0	Nat NO ₃	(II) H
Oxygen atom -	Formula ann of sodium nitrate	Water mulecule

() Remember

- * Atom is the smallest building unit of matter which participates in chemical reactions.
- * Molecule is the smallest fundamental part of matter which can exist solely, and retain the properties of this matter.

Note

* lonic compounds exist in the form of a regular geometrical structure known as the crystal lattice, where each ion is surrounded by opposing ions (in terms of charge) from all directions.



Bull and stick model of the crystal lattice of sodium chloride

Worked Example

Which of the following equations represents the process of dissolving the table salt in water?

(a)
$$NaCl_{(aq)} \xrightarrow{water} Na_{(aq)}^+ + Cl_{(aq)}^-$$

$$\textcircled{b} \operatorname{NaCl}_{(s)} \xrightarrow{\operatorname{water}} \operatorname{Na}_{(s)}^+ + \operatorname{Cl}_{(s)}$$

$$\bigcirc$$
 NaCl_(s) $\xrightarrow{\text{water}}$ Na⁺_(aq) + Cl⁻_(aq)

$$\bigcirc$$
 NaCl_(aq) $\xrightarrow{\text{water}}$ Na⁺_(s) + Cl⁻_(g)

Idea of answering:

- .. The ionic compounds such as table salt are found in form of solid crystals.
- .. The choices (a) and (d) are excluded.
- The crystal lattice of sodium chloride salt dissociates in water into Na⁺_(aq) and Cl⁻_(aq) ions.
- ... The equation which represents the dissolution of the table salt in water is $NaCl_{(s)} \xrightarrow{water} Na^+_{(aq)} + Cl^-_{(aq)}$

Answer: The correct choice is c

* It is difficult practically to deal with the atom, the molecule or the formula unit in chemical calculations, as they are extremely small particles where their dimensions are estimated in nano scale.

The mole

* It represents the amounts of chemical substances in the international system of units (SI), where it is equivalent to the amount of a substance which contains the same number of units (atoms, ions, molecules or formula units) that exist in 12 g of carbon-12 (\frac{12}{6}C).



A mole of carbon

(a) Wighted Examples

- - (a) number of moles of Na atoms.
 - (b) number of moles of S atoms.
 - (c) number of moles of O atoms.
 - (d) number of moles of ions in the aqueous solution.

Idea of answering:

The following table shows the number of moles of each of the atoms and the ions in one mole of each of the two compounds:

	Na ₂ SO ₃	Na ₂ SO ₄
Number of moles of Na atoms	2 mol	2 mol
Number of moles of S atoms	1 mol	1 mol
Number of moles of () atoms	3 mol	4 mol
Number of males of the ions in the aqueous solution	3 mol	3 mol

Answer: The correct choice is ©

Which of the following shows the number of moles of each of magnesium chloride formula units, and sulphate anions in a mixture of magnesium chloride and magnesium sulphate which contains 4 mol CI⁻ and 3 mol Mg²⁺?

Choices	Number of moles of magnesium chloride formula units	Number of moles of sulphate anions
(a)	1 mol	1 mol
b	2 mol	1 mol
©	2 mol	3 mol
d	3 mol	4 mol

Idea of answering:

- : The mixture consists of:
 - Magnesium chloride MgCl, which dissociates in water according to the equation :

$$MgCl_{2(s)} \xrightarrow{water} Mg^{2+}_{(aq)} + 2Cl^{-}_{(aq)} \dots (1$$

- Magnesium sulphate MgSO₄ which dissociates in water according to the equation :

$$MgSO_{4(s)} \xrightarrow{water} Mg^{2+}_{(aq)} + SO^{2-}_{4(aq)} \dots (2)$$

- .. The mixture contains 4 mol of Cl ions.
- \therefore The coefficients of the equation (1) are multiplied \times 2

$$2MgCl_{2(s)}$$
 \xrightarrow{water} $2Mg^{2+}_{(aq)}$ + $4Cl_{(aq)}$... 3

By addition of the equations (2) and (3), it is found that:

$$2MgCl_{2(s)} + MgSO_{4(s)} \xrightarrow{water} 3Mg_{(aq)}^{2+} + 4Cl_{(aq)}^{-} + SO_{4(aq)}^{2-}$$

- .. Number of moles of formula units of magnesium chloride in the mixture = 2 mol
 - , number of moles of sulphate anions in the mixture = 1 mol

Answer: The correct choice is (b)

Test bourself

What is the number of the moles of magnesium phosphate ${\rm Mg_3(PO_4)_2}$ which contains 0.25 mol of oxygen atoms ?

(a)
$$1.25 \times 10^{-2}$$
 mol

(b)
$$2 \times 10^{-2}$$
 mol

©
$$2.5 \times 10^{-2}$$
 mol

(d)
$$3.125 \times 10^{-2}$$
 mol

Idea of answering:

:. Number of Mg₃(PO₄)₂ moles = mol

Answer: The correct choice is

Molarmasi

- The mass of one atom is called it is estimated in a unit known as
- , which is a very small amount,
- When the atomic mass of an element is estimated in grams,
 it is called the molar mass of atom, it is estimated in (g/mol)

as shown in the examples illustrated in the following table:

Element	Hydrogen H	Carbon C	Nitrogen N	Oxygen O	Sodium Na	Sulphur S_
Atomic mass	1 u	12 u	14 u	16 u	23 u	32 u
Molar mass of atom	i g/mol	12 g/mol	14 g/mol	16 g/mol	23 g/mol	32 g/mol

• The sum of gram atomic masses of the atoms that compose the molecule is known as gram molecular mass (g), or the molar mass (g/mol).

pplication

The molar mass of hydrated copper sulphate crystals CuSO_{4.5}H₂O

CuSO₄.511₂O

Cu + S + (4×0) + $(5\times2\times10)$ + (5×0) (63.5) + (32) + (4×16) + $(5\times2\times1)$ + (5×16) (63.5) + (32) + (4×16) + $(5\times2\times1)$ + (5×16)

Worked Example

Calculate the molar mass of each of :

- (1) Methanol CH₃OH
- (2) Sucrose C₁₂H₂₂O₁₁

C = 12 H = 1 O = 16

Answer:

- (1) Molar mass of methanol $CH_3OH = 12 + (4 \times 1) + 16 = 32 \text{ g/mol}$
- (2) Molar mass of sucrose $C_{12}H_{22}O_{11} = (12 \times 12) + (22 \times 1) + (11 \times 16) = 342 \text{ g/mol}$

Molar masses of the elements with diatomic molecules

• The molar mass of a diatomic molecule of an element equals double its atomic molar mass, as in the following table:

Element	Hydrogen	Nitrogen	Oxygen	Fluorine	Chlorine	Bromine	lodine
Molar mass	н	N	o	F	CI	Br	1
of atom	1 g/mol	14 g/mol	16 g/mol	19 g/mol	35.5 g/mol	80 g/mol	127 g/mol
Molar mass	H ₂	N ₂	02	F ₂	Cl ₂	Br ₂	I ₂
of molecule	$2 \times 1 =$	$2 \times 14 =$	$2 \times 16 =$	$2 \times 19 =$	$2 \times 35.5 =$	$2 \times 80 =$	$2 \times 127 =$
	2 g/mol	28 g/mol	32 g/mol	38 g/mol	71 g/mol	160 g/mol	254 g/mol

Worked Example

Which of the following masses of oxygen and hydrogen are equal?

 $\{0, 16, 11 = 1\}$

Choices	Oxygen	Hydrogen
(a)	1 mol of atoms	32 mol of molecules
b	1 mol of molecules	8 mol of atoms
©	1 mol of molecules	16 mol of atoms
d	1 mol of atoms	8 mol of molecules

Idea of answering:

- : Mass of 1 mol of O atoms = $1 \times 16 = 16$ g , mass of 32 mol of H₂ molecules = $32 \times (2 \times 1) = 64$ g
- .. The choice (a) is excluded.
- : Mass of 1 mol of O_2 molecules = 1 × (2 × 16) = 32 g , mass of 8 mol of H atoms = 8 × 1 = 8 g
- .. The choice (b) is excluded.
- : Mass of 1 mol of O_2 molecules = 1 × (2 × 16) = 32 g , mass of 16 mol of H atoms = 16 × 1 = 16 g
- ∴ The choice © is excluded.
- : Mass of 1 mol of O atoms = $1 \times 16 = 16 \text{ g}$, mass of 8 mol of H₂ molecules = $8 \times (2 \times 1) = 16 \text{ g}$
- ∴ Mass of 1 mol of O atoms = Mass of 8 mol of H₂ molecules.

Answer: The correct choice is d

The difference of the molar mass according to the physical state

• The molar masses of some molecules of some elements differ according to their physical states, due to the difference of their molecular structure.

Molar masses of vapours of phosphorus and sulphur.

Element	Phosphorus	Sulphur
Gram atomic mass	31 g	32 g
Building units	Each molecule consists	Each molecule consists
	of 4 atoms	of 8 atoms
	P ₄	S ₈
	(4 atoms)	(8 atoms)
The molecule of the element		
In its vapour state		E PA

Gram molecular mass in the vapour state $4 \times 31 = 124 \, \mu \, \text{mol}$ $8 \times 32 = 256 \, \text{g mol}$



Which of the following moles of the molecules of the gases and vapours contains the least number of moles of atoms?

a Sułphur vapours.

(b) Nitrogen gas.

© Bromine vapours.

d Helium gas.

Idea of answering:

The following table exhibits the formulas of the molecules of the substances mentioned in the four choices:

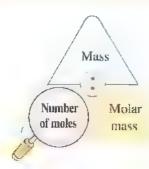
The substance	Sulphur vapours	Nitrogen gas	Bromine vapours	Helium gas
The formula of its molecule	S ₈	N_2	Br ₂	He

Answer: The correct choice is

Calculation of the number of moles

• We can calculate the number of moles by using the following relation:

Number of moles (mol) = $\frac{\text{Mass of substance (g)}}{\text{Molar mass (mass of one mole) (g/mol)}}$



Worked Examples

What is the number of moles of carbon atoms in a sample of it, its mass equals 144 g?

[C = 12]

- (a) 6 mol
- (b) 12 mol
- (c) 18 mol
- (d) 24 mol

Idea of answering:

Number of moles of carbon atoms = $\frac{\text{Mass of carbon}}{\text{Molar mass of carbon}}$ = $\frac{144}{12}$ = 12 mol

Answer: The correct choice is (b)

Calculate the number of moles of water found in 36 g of it.

[H = 1, O = [6]]

Answer:

- The molar mass of $H_2O = (2 \times 1) + 16 = 18$ g/mol
- The number of moles of water = $\frac{\text{Mass of water}}{\text{Molar mass of water}}$ = $\frac{36}{18}$ = 2 mol

(1) Which of the following compounds the mass of 0.256 mol of it equals 12.928 g?

a C,H,O

(b) CO₂

[C = 12, H = 1, O = 16, Cl = 35.5]

© C2H6

d CH₃Cl

Idea of answering:

- * The molar mass of the compound is calculated by the indication of the number of its moles and its mass.
- The molar mass of the compound = $\frac{\text{Mass of the compound}}{\text{Number of moles}} = \frac{12.928}{0.256} = 50.5 \text{ g/mol}$
- The correct choice is that which has the same molar mass (50.5 g/mol).
- : Molar mass of $C_2H_4O = (2 \times 12) + (4 \times 1) + 16 = 44 \text{ g/mol}$
- .. The choice (a) is excluded.
- : Molar mass of $CO_2 = 12 + (2 \times 16) = 44 \text{ g/mol}$
- The choice b is excluded.
- : Molar mass of $C_2H_6 = (2 \times 12) + (6 \times 1) = 30 \text{ g/mol}$
- : The choice © is excluded.
- : Molar mass of $CH_3Cl = 12 + (3 \times 1) + 35.5 = 50.5$ g/mol
- : The mass of 0.256 mol of CH₃Cl equals 12.928 g

Answer: The correct choice is d

What is the mass of oxygen in a sample of Na₂SO₄.10H₂O crystals its mass is 32.2 g?

(a) 50.79 g

(b) 22.4 g [Na,SO₃ = 142 g/mol , H,O = 18 g/mol , O = 16]

© 16 g

d 0.4 g

Idea of answering:

Na₂SO₄·10H₂O
$$\xrightarrow{\text{contains}}$$
 40 + 10 O
1 mol 14 mol
142 + (10 × 18) = 322 g/mol $14 \times 16 = 224 \text{ g}$
32.2 g $?$ g

Mass of oxygen in the sample = $\frac{32.2 \times 224}{322}$ = 22.4 g

Answer: The correct choice is (b)

1 If the mass of 0.5 mol of the compound WCL, equals 125 g:

- (1) Calculate the number of moles of chloride ions in a sample of this compound its mass = 250 g
- (2) Calculate the molar mass of the compound WBr.2

(1 35.5 B) S0

Answer:

$$\therefore$$
 Number of moles of WCl₂ = $\frac{0.5 \times 250}{125}$ = 1 mol

- ... Number of moles of chloride ions Cl⁻ = 2 mol
- (2) Mass of 2 mol of C1 $= 2 \times 35.5 = 71$ g
 - :. Mass of W²⁺ ion = Mass of WCl₂ Mass of 2 mol of Cl = 250 71 = 179 g
 - :. Molar mass of WBr₂ = $179 + (2 \times 80) = 339 \text{ g/mol}$

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(Mass – Mass) calculations

Worked Example

What is the mass of calcium oxide produced from the thermal decomposition of 10 g of calcium carbonate ? [Ca = 40, C = 12, O = 16]

- (a) 178 g
- (b) 56 g
- © 17.8 g
- d) 5.6 g

Idea of answering:

Molar mass of $CaCO_3 = 40 + 12 + (3 \times 16) = 100 \text{ g/mol}$

Molar mass of CaO = 40 + 16 = 56 g/mol

CaCO_{3(s)}
$$\xrightarrow{\Delta}$$
 CaO_(s) + CO_{2(g)}
100 g/mol 56 g/mol 10 g ? g

The produced mass of calcium oxide = $\frac{10 \times 56}{100}$ = 5.6 g

Answer: The correct choice is

(Mole – Mass) calculations

Worked Example)

What is the mass of NaCl produced from the reaction of 2 mol of NaOH with excess of HCl according to the equation: $NaOH_{(aq)} + HCl_{(aq)} - NaCl_{(aq)} + H_2O_{(\ell)}$?

(a) 29.25 g

(b) 58.5 g

[Na = 23, C] = 35.5

© 117 g

d 234 g

Idea of answering 1:

Idea of answering 2 :

Molar mass of NaCl = 23 + 35.5 = 58.5 g/mol

Number of NaCl moles = 2 mol

Mass of produced NaCl =
$$\frac{2 \times 58.5}{1}$$

= 117 g

Answer: The correct choice is (c)



Warked Example

When modern cars collide with a wall, air bags are inflated instantaneously with nitrogen gas, as a result of these two following reactions:

$$*2NaN_3 \longrightarrow 2Na + 3N_2$$

*
$$10\text{Na} + 2\text{KNO}_3 \longrightarrow \text{K}_2\text{O} + 5\text{Na}_2\text{O} + \text{N}_2 \qquad \dots \bigcirc 2$$

What is the total number of moles of nitrogen gas which are produced from the decomposition of 1 mol of sodium azide NaN3 in excess of KNO3?

Idea of answering:

By multiplying the coefficients of the equation 1×5 , then adding it to the equation 2

Total number of moles of nitrogen gas = $\frac{1 \times 16}{10}$ = 1.6 mol

Answer: The correct choice is (b)

Test Vourself

Which of the following compounds when 1 mol of it is burnt, it produces 54 g of water vapour? [61 = 0, 1 = H]

$$\bigcirc C_3H_8$$

Idea of answering:

- Calculation of the number of moles of $H_2O_{(v)}$ in 54 g of it.
- Number of H_2O moles = $\frac{Mass \text{ of } H_2O}{Molar \text{ mass of } H_2O} = \frac{54}{18} = 3 \text{ mol}$
- Writing the balanced equation of burning each compound.
- The correct compound is the one which when 1 mol of it is burnt, it produces 3 mol of H₂O_(y)

Answer: The correct choice is

Questians: 🤶



Choose	the	correct	answer:
CHOOSE	1111	COHEST	ALLYMPI

			Answer them yourself
Choose the cor	rect answer:		
(1) If the atomic r	nass of phosphorus is 31	u, the molar mass of	phosphorus molecule in
its vapor state	is		
a. 31 g/mol	b. 62 g/mol	c. 124 g/mol	d. 155 g/mol
(2) The number of	moles of potassium nitra	ite in 202 g of it is	8 W O- 10 V
a. 0.5 mol	b. 1 mol	c.2 mol	d. 2.5 mol
(3) What is the nu	mber of oxygen atoms i	n the formula unit of	$Ca_3(PO_4)_2$?
a. 2 atoms.	b. 4 atoms.	c. 7 atoms.	d 8 atoms.
(4) The mass of 0	.I mol of sodium hydrox	ude equals .	N 10 10 1
a. 0.04 g	b. 0.4 g	c. 4 g	d. 40 g
(5) CaO mass whi	ich is produced from the	thermal decomposition	on of 50 g of CaCO ₃
equals	***		$[C_0 = 40], O = 16], C = 12]$
a. 14 g	b. 28 g	c. 82 g	d. 96 g
(6) Butane burns a	according to the equation	n:	
	$2C_4H_{10(g)} + 13O_{2(g)}$	<u>Δ</u> > 8CO _{2(g)} + 10H	(2O(v)
What is the nu	imber of moles of carbo	n dioxide gas produce	d from burning 3 mol of
butane gas (C	H ₁₀) ?		
u. 4 mol	b. 8 mol	c. 12 mol	d. 24 mol
(7) When 80.5 g o	of sodium react with wat	er, according to the fo	ollowing equation:
	$2Na_{(s)} + 2H_2O_{(l)}$	2NaOH _(aq) + H _{2(g}	2)
The required r	number of water moles to	o complete this reaction	on is \\1-23
a. 2 mol	b. 2.5 mol	c. 3.5 mol	d. 7 mol
Calculate the m	nolar mass of :		

(1) S₈ (2) CO₂ (3) NaCl (4) HNO₃ [S = 32, C = 12, O = 16, Na = 23, C] = 35.5, H = 1, N = 14]



Open book questions

Answered





The mole

- What is the number of the atoms in the formula unit of calcium bicarbonate Ca(HCO₃)₂?
 - (a) 9 atoms.

b) 10 atoms.

(c) 11 atoms.

- (d) 12 atoms.
- A mole of potassium dichromate contains
 - (a) 1 mol of K

(b) 4 mol of Cr

- © 7 mol of O
- (d) 1 mol of Cr
- Which of the following molecules, a mole of it contains the highest number of moles of the atoms?
 - (a) S_{g}

(b) C₁₀H₈

(C) Al₂(SO₄)₃

- (d) Na₃PO₄
- In the balanced equation:

$$Fe_3O_4 + X \longrightarrow FeCl_2 + 4H_2O + 2FeCl_3$$

What does (X) represent?

- a 4 mol of Cl,
- b 8 mol of Cl₂
- © 8 mol of HCl (d) 6 mol of HCl
- Propane $\mathrm{C_3H_8}$ burns according to the equation :

$$C_3H_{8(g)} + 5O_{2(g)} \xrightarrow{\Delta} 3CO_{2(g)} + 4H_2O_{(v)}$$

Which of the following represents the correct ratio between oxygen and propane gases as reactants?

© $\frac{10 \text{ g O}_2}{11 \text{ g C}_3 \text{H}_8}$

The molar mass

6	The ratio between the molar mass of the solid phosphorus to that of phosphorus
1	in its vapour state is

(d) 1:4

(b) 2:1

©3:1

(0) 4:1

 $B_{1} = \{37, 8 = 32, 0 = [6]\}$

(a) 217 g/mol

(b) 233 g/mol

© 354 g/mol

d 514 g/mol

8 What is the mass of aluminum in 306 g of aluminum oxide Al_2O_3 ?

||A|| = 27, O = 161

(d) 81 g

(b) 162 g

(c) 200 g

(d) 243 g

[O = 16, H = 1]

(a) 62 g

(b) 59 g

(c) 30 g

(d) 27 g

If the chemical formula of antimony oxide is Sb_2O_3 and that of sodium phosphate is Na_3PO_4 What is the molar mass of antimony phosphate?

- (a) 216.8 g/mol
- (b) 338.6 g/mol
- © 460.4 g/mol
- d 528.6 g/mol

Element (X) its gram atomic mass is 32 g/mol and its electronic configuration is (2,8,6).

 Element (Y) its gram atomic mass is 35.5 g/mol and its electronic configuration is (2,8,7).

What is the gram molecular mass of the compound produced from combining the atoms of the two elements (X) and (Y)?

- (a) 67 g/mol
- (b) 99 g/mol
- © 103 g/mol
- d) 134 g/mol

Calculations of the number of moles

1	2 🙏 Which of these samples	contains the highest numbe	er of moles of carbon atoms?
	(a) 29 g of C ₄ H ₁₀		[C = 12, B = 1, O = 16]
	(b) 23 g of C ₂ H ₅ OH		
	© 22 g of CO ₂		
	(l) 90 g of C ₆ H ₁₂ O ₆		
1	What is the total number of	moles of the ions found in	240 g of NH ₄ NO ₃ ?
	a 3 mol	(b) 6 mol	[N = 14, O = 16, H = 1]
	© 9 mol	(d) 27 mol	
1	🕽 🙏 Which of the following s	amples contains the same r	number of moles of CaSO ₄
	in 272 g of it ?	(Cu	= 40 , $S = 32$, $Cl = 35.5$, $O = 16$, $N = 14$
	(a) 142 g of chlorine gas.	(b) 40 g of oxygen gas.	
	© 35 g of nitrogen gas.	(1) 2 g of hydrogen gas.	
1	🕽 🙏 What is the number of m	noles of an ions which comb	oine with 138 g of the cations
	in sodium carbonate salt ?		[Na = 23]
	(a) 1,3 mol	b 3 mol	
	© 6 mol	(d) 23 mol	
1	(Mass - Mass) calculations		
1	In the reaction: \mathbf{CH}_{46}	$_{g)} + 4Cl_{2(g)} \longrightarrow CCl_{4(f)} + 4$	IHCl _(g)
		•	eaction of 5.14 g of methane
	with excess of chlorine gas	?	[C = 12 : H = 1 : Ct = 35.5]
	(a) 12.3 g	b 0.54 g	
	© 791 g	d 49.47 g	
Ċ	What is the mass of the sub	stance produced from the c	omplete burning of a strip of
	magnesium whose mass equ	ıals 12 g in air ?	$M_{\rm g} = 24 / O = 16$
	(a) 12 g	(b) 20 g	
	© 40 g	(d) 56 g	

18 ___ 0.225 g of the metal (X) reacts with oxygen gas forming 0.425 g of the compound X2O3

What is the gram atomic mass of (X)?

10 = 161

(1) 58 g/mol

(c) 25 g/mol

- (d) 27 g/mol
- 🔟 🚬 Two atoms of rubidium Rb combine with one atom of oxygen O to form rubidium oxide.

What is the mass of rubidium oxide which is produced from the reaction of 1.98 g of rubidium with excess of oxygen gas?

(a) 1.81 g

(b) 2.17 g

(c) 4.3 g

(d) 8.6 g

(Mole - Mass) calculations

 $3Mg + N_2 \xrightarrow{\Delta} Mg_3N_2$ 20 In the reaction :

What is the number of moles of nitrogen gas which react with 18 g of magnesium to form magnesium nitride compound?

(a) 0.25 mol

(b) 0.5 mol

(c) 1 mol

- (d) 2 mol
- 🚬 On passing water vapour over red hot coke, the following reaction occurs :

$$H_2O_{(v)} + C_{(s)} \xrightarrow{\Delta} CO_{(g)} + H_{2(g)}$$

What is the number of moles of the gases remaining in the reaction medium when 9 g of water vapour react with excess coke "assuming that the reaction container is closed"?

[H = 1, O = 16, C = 12]

[O = 16]

(a) 0.5 mol

(b) 1 mol

(c) 2 mol

- (d) 3 mol
- 💯 🊬 Which of the following compounds 1 mol of it requires 96 g of oxygen gas to be burnt completely?
 - (a) CH₃CHO

(b) C₂H₅OH

C C H

⊕ CH,COOH

(Mole - Mole) calculations

- From the reaction equation : $4NH_{3(g)} + 7O_{2(g)} \longrightarrow 4NO_{2(g)} + 6H_2O_{(v)}$ What is the least number of moles of oxygen required to oxidize 16 mol of ammonia gas ?
 - (a) 16 mol

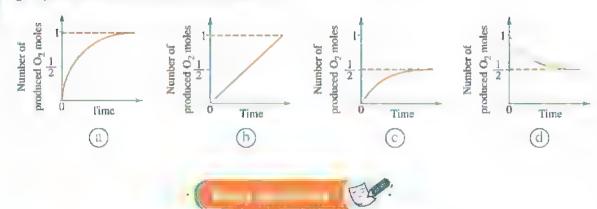
(b) 28 mol

© 64 mol

- (d) 80 mol
- Hydrogen peroxide decomposes according to the following equation:

$$2H_2O_{2(f)} \longrightarrow 2H_2O_{(f)} + O_{2(g)}$$

Which of the following graphical figures represents the number of moles of oxygen gas produced at the end of the reaction?



Calculation of the number of moles

- Calculate the molar mass of lead element, knowing that the mass of 0.2 mol of it equals 41.4 g
- 26 Calculate the mass of oxygen in 25.99 g of potassium chromate compound.

$$[K = 39, Cr = 52, O = 16]$$

Calculate the number of moles of ammonium ions in a sample of ammonium carbonate salt its mass = 22.5 g [N = 14.H = 1.C = 12.O = 16]

(Mass - Mass) calculations

28 Calculate the mass of carbon dioxide gas produced from burning 233.1 g

of ethylene gas C₂H₄ in excess of oxygen gas, according to the following equation:

$$C_2H_{4(g)} + 3O_{2(g)} \xrightarrow{\Delta} 2CO_{2(g)} + 2H_2O_{(v)}$$
 [C = 12, H = 1, O = 16]

Sulphur is prepared from hydrogen sulphide in two steps, which are

1
$$2H_2S + 3O_2 \longrightarrow 2SO_2 + 2H_2O$$

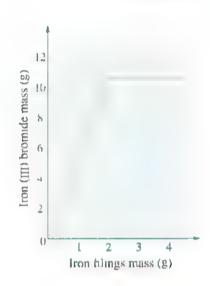
$$2 SO_2 + 2H_2S \longrightarrow 3S + 2H_2O$$

Calculate the mass of sulphur which is produced from the consumption of 21.5 g of oxygen. [S = 32.0 = 16]

The opposite graph represents the mass of iron (III) bromide produced from the reaction of iron filings with a definite mass of bromine at convenient conditions.

Calculate the gram atomic mass of bromine.

[Fe = 55.8]



(Mole - Mass) calculations

$$2\text{FeSO}_4 \xrightarrow{\Delta} \text{Fe}_2\text{O}_3 + \text{SO}_2 + \text{SO}_3$$

(Mole - Mole) calculations

- Iron reacts with sulphur to form iron (III) sulphide, calculate the number of moles of:
 - (1) Sulphur which are required to react with 6.2 mol of iron.
 - (2) Iron (III) sulphide produced from the reaction of 10.6 mol of iron with excess of sulphur.

Choosing two out of five choices questions :

- 1 mol of potassium carbonate differs from 1 mol of potassium bicarbonate in
 - (a) the number of K atoms,
 - (b) the number of O atoms.
 - (c) the number of C atoms.
 - d the number of H atoms.
 - (e) the number of the anions.
- 5.4 g of Mn are found in each of the following, except

Mn = 55, K = 39, O = 161

- (a) 14 g of MnO
- (b) 7.8 g of Mn₂O₃
- © 8.6 g of MnO₂
- d 9.8 g of K₂MnO₄
- e 15.7 g of KMnO₄







The mole and Avogadro's number

 6.02×10^{23}

atoms

atoms

Cu

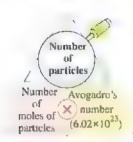
atoms

1 mol of Cu

- * The Italian scientist Amedeo Avogadro discovered that the number of particles (molecules, atoms, ions or formula units) that are found in one mole of any substance is a constant number, this number, later, was named after Avogadro's name (Avogadro's number) to honor him.
- I mol of C * Based on this, Avoqadro's number can be defined as One male of any substance contains Avogadro's number of particles the number of molecules, atoms, ions or formula units which are found in one mole of substance and it equals 6.02×10^{23}
- * In the light of the definition of Avogadro's number, the mole can be defined as the amount of substance that contains Avoqadro's number of particles (molecules, atoms, ions or formula units).



* Number of particles (molecules, atoms or ions)
which are found in a definite amount of a substance
(number of moles) can be calculated in terms
of Avogadro's number,



using the relation:

Number of = Number of moles of × Avogadro's number

Molecules | Atoms | Ions | Molecules | Atoms | Ions | 6.02×10²³

Worked Examples

- 1 What is the number of sodium ions in 0.2 mol of sodium sulphate?
 - (a) 0.2 ion.
 - (b) 0.4 ion.
 - © 2.408×10^{23} ions.
 - (d) 1.204×10^{23} ions.

Idea of answering:

$$Na_2SO_4$$
 contains $2Na^+ + SO_4^2$ 1 mol 2 mol 2 mol 3 mol 3 mol 3 mol 3 mol 3 mol 4 mol 4

Number of moles of sodium ions $Na^+ = 2 \times 0.2 = 0.4$ mol

Number of sodium ions Na⁺ = Number of moles of ions × Avogadro's number

$$= 0.4 \times 6.02 \times 10^{23} = 2.408 \times 10^{23}$$
 ions

Answer: The correct choice is ©

2 What is the number of molecules of sulphur dioxide found in a sample of it,

its mass = 32 g?

[S = 32, O = 16]

(a) 3.01×10^{23} molecules.

(b) 0.5 molecule.

 \bigcirc 6.02 × 10²³ molecules.

(d) 12.04×10^{23} molecules.

Idea of answering:

Molar mass of $SO_2 = 32 + (2 \times 16) = 64 \text{ g/mol}$

Number of
$$SO_2$$
 moles = $\frac{Mass \text{ of the substance}}{Molar \text{ mass of this substance}} = \frac{32}{64} - 0.5 \text{ mol}$

Number of SO₂ molecules = Number of moles of molecules × Avogadro's number

$$= 0.5 \times 6.02 \times 10^{23} = 3.01 \times 10^{23}$$
 molecules

Answer: The correct choice is (a)

(3) Calculate the number of carbon atoms in 50 g of calcium carbonate. → 3 40, (3.12, 0 = 16

Answer

Molar mass of $CaCO_3 = 40 + 12 + (3 \times 16) = 100 \text{ g/mol}$

Number of moles of $CaCO_3 = \frac{CaCO_3 \text{ mass}}{CaCO_3 \text{ molar mass}} = \frac{50}{100} = 0.5 \text{ mol}$

Number of moles of carbon atoms = $1 \times 0.5 = 0.5$ mol

Number of carbon atoms = Number of moles of carbon atoms × Avogadro's number

$$= 0.5 \times 6.02 \times 10^{23} = 3.01 \times 10^{23}$$
 atoms

Another answer:

CaCO₃ contains C

1 mol 1 mol

100 g
$$6.02 \times 10^{23}$$
 atoms

50 g ? atoms

Number of carbon atoms = $\frac{6.02 \times 10^{23} \times 50}{100} = 3.01 \times 10^{23}$ atoms

A sample of a compound contains 5 g of hydrogen [H = 1], 35 g of nitrogen and 60 g of oxygen, calculate the number of hydrogen molecules in another sample of this compound, its mass equals 154.4 g

Answer:

Mass of the first sample = 5 + 35 + 60 = 100 g

Mass of the sample — Mass of hydrogen in the sample

First sample 100 g

5 g

Second sample 154.4 g

? g

Mass of hydrogen in the second sample = $\frac{5 \times 154.4}{100}$ = 7.72 g

Number of hydrogen molecules moles = $\frac{H \text{ mass}}{H_2 \text{ molar mass}}$

$$=\frac{7.72}{2}$$
 = 3.86 mol

Number of hydrogen molecules = Number of moles of hydrogen molecules × Avogadro's number

$$= 3.86 \times 6.02 \times 10^{23} = 23.24 \times 10^{23}$$
 molecules

Calculate the number of atoms of the elements in 0.111 mol of Fe(CO)₃(PH₃)₂

Answer:

0.111 mol ? mol of atoms

The number of moles of atoms of the elements =

 $= 1 \times 10^{24}$ atoms The number of atoms of the elements =

The limiting reactant in the real lion

To clarify and simplify the concept of the limiting reactant, the following application will be studied:

* When you buy an egg carton, you will find that this one egg carton contains 30 eggs , this can be expressed by the following equation:



- * Can you determine mathematically the number of egg cartons which can be prepared from :
- 150 eggs. 4 empty cartons.

Which of them its number exceeds the required number for the filling process, eggs or empty cartons?

* This can be concluded through the previous equation, as follows:

Number of egg cartons depending on:

Using all the eggs Using all empty cartons 1 egg carton 1 empty carton 1 egg carton 4 empty cartons 2 egg cartons Number of egg cartons Number of egg cartons Solution 1 egg carton 4 empty cartons 2 egg cartons Number of egg cartons 4 egg cartons 1 egg cartons 2 egg cartons

* According v, it is obvious that to use all the eggs in the filling, we need 5 empty cartons while the available empty cartons are only 4, therefore not all the eggs will be used but all the empty cartons will be used to produce egg cartons in a number that is lower than the number of the egg cartons which would be produced if we used all eggs, this is why we call the empty cartons "the 1 miting is count" of the process of filling.

* Number of used eggs and the number of remaining eggs can be calculated, as follows:

Number of used eggs =
$$\frac{4 \times 30}{1}$$
 = 120 eggs

The remaining (excess amount) of eggs after filling = 150 - 120 = 30 eggs.

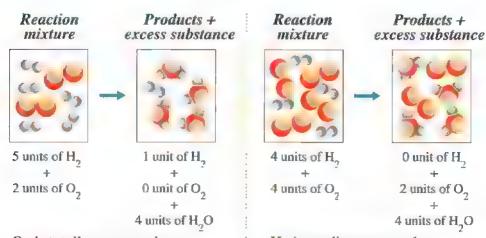
In the same manner:

- * Obtaining definite amounts of products through the chemical reactions requires using definite amounts of the reactants, but if the amount of one of the reactants exceeded the required amount for the reaction, this excess amount remains without being consumed in the reaction.
- * The substance which is totally consumed during the chemical reaction, and results in producing the lower amount of the product (limits the amount of the product) is known as the limiting reactant.



The reaction of formation of water.

$$2H_{2(g)} + O_{2(g)} \xrightarrow{\Delta} 2H_2O_{(v)}$$



- : O₂ is totally consumed.
- ∴ H₂ is totally consumed.
- \therefore Oxygen O_2 is the limiting reactant. \therefore Hydrogen H_2 is the limiting reactant.

Worked Examples

potassium hydroxide solution reacts with sulphuric acid according to the following equation:

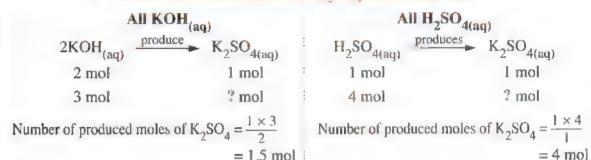
$$2KOH_{(aq)} + H_2SO_{4(aq)} \longrightarrow K_2SO_{4(aq)} + 2H_2O_{(f)}$$

What is the limiting reactant, when 4 mol of sulphuric acid are present with 3 mol of potassium hydroxide in the reaction medium?



Answer:

Number of produced moles of K, SO, on consuming:



- : The lower number of moles of K2SO4 is produced as a result of consuming all KOH moles.
- .. Potassium hydroxide KOH is the limiting reactant in this reaction.

Another answer:

Number of used moles The molar ratio of the compound = The coefficient of the compound in the balanced equation

Molar ratio of KOH =
$$\frac{3}{2}$$
 = 1.5 Molar ratio of H₂SO₄ = $\frac{4}{1}$ = 4

Molar ratio of
$$H_2SO_4 = \frac{4}{1} = 4$$

- : The molar ratio of KOH is lower than that of H₂SO₄
- .. The limiting reactant in this reaction is potassium hydroxide KOH

7 g of iron react with 4 g of sulphur and produce 11 g of iron (II) sulphide.

What will remain in the reaction container when $7 \, \mathrm{g}$ of iron are added to $7 \, \mathrm{g}$ of sulphur?

- (a) 14 g of iron (II) sulphide only.
- (b) 11 g of iron (II) sulphide, 3 g of iron.
- (c) 11 g of iron (II) sulphide only.
- (d) 11 g of iron (II) sulphide, 3 g of sulphur.

Idea of answering:

- : Each 7 g of Fe react completely with 4 g of S to form 11 g of FeS
- \therefore 11 g of FeS will be formed with remaining of (7 4 = 3 g) of unreacted sulphur.

Answer: The correct choice is (d)

3 10 g of water vapour are passed on 16.8 g of iron which is heated till redness, according to the reaction:

$$3Fe_{(s)} + 4H_2O_{(v)} \xrightarrow{\Delta} Fe_3O_{4(s)} + 4H_{2(g)}$$

Which of the following represents properly this reaction?

[1/e = 55.9], H = 1., O = 16

Choices	The limiting reactant in the reaction	The amount of the produced ${ m F_3O_4}$
(a)	H ₂ O	0.9 mol
b	Fe	0.9 mol
©	Fe	0.1 mol
d	H ₂ O	0.1 mol

Idea of answering:

- Molar mass of $H_2O = (1 \times 2) + 16 = 18$ g/mol
- Number of moles of $H_2O = \frac{10}{18} = 0.56$ mol
- Number of moles of Fe = $\frac{16.8}{55.9}$ = 0.3 mol

Number of moles of Fe₃O₄ produced on consuming

All
$$Fe_{(s)}$$
 $3Fe_{(s)} \longrightarrow Fe_3O_{4(s)}$
 3 mol
 1 mol
 0.3 mol

No. of produced Fe_3O_4 moles = $\frac{0.3}{3}$
 1 mol

No. of produced Fe_3O_4 moles = $\frac{0.56}{4}$
 1 mol

No. of produced 1 mol
 1

- :. The lower number of Fe₃O₄ moles is produced on consuming all Fe moles.
- \therefore The limiting reactant in the reaction is Fe, and the produced amount of Fe₃O₄ is 0.1 mol

Answer: The correct choice is (c)

Calcium oxide reacts with water according to the following equation:

$$CaO_{(s)} + H_2O_{(t)} \longrightarrow Ca(OH)_{2(aq)}$$

Which of the following is the remaining unreacted mass of water, when 1.45 g of H₂O are added to 1.5 g of CaO?

|Ca = 40|, H = 1|, O = 16|

(a) 0.48 g

(b) 0.97 g

(c) 1.5 g

(d) 1.8 g

Idea of answering:

CaO_(s) reacts with
$$H_2O_{(l)}$$

 $40 + 16 = 56 \text{ g}$ $(2 \times 1) + 16 = 18 \text{ g}$
1.5 g ? g

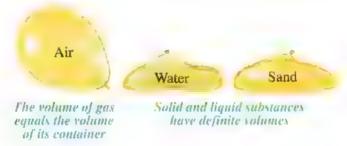
The reacted mass of water = $\frac{1.5 \times 18}{56}$ = 0.48 g

The remaining unreacted mass of water = 1.45 - 0.48 = 0.97 g

Answer: The correct choice is (b)

the column of a

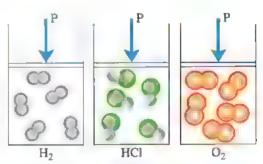
* Solid and liquid substances have definite and constant volumes, which can be measured by several methods, while the volumes of the gaseous substances equal the volumes of their containers.



* The scientist Avogadro stated the relation between the volumes of gases and their number of molecules known as

Avogadro's postulate.

this postulate states that equal volumes of different gases - at the same conditions of temperature and pressure - contain equal numbers of molecules.



Equal volumes of different gases contain the same number of molecules at the same conditions of temperature and pressure

Worked Example

Which of the following is an application of Avogadro's postulate at the standard conditions?

- (a) 10 g of O₂ gas contain the same number of molecules found in 10 g of H₂ gas.
- b 10 g of O_2 gas contain the same number of molecules found in 10 L of H_2 gas.
- © 10 L of O₂ gas contain the same number of molecules found in 10 mol of H₂ gas.
- \bigcirc 10 L of \bigcirc gas contain the same number of molecules found in 10 L of \bigcirc gas.

Idea of answering:

: Equal volumes of different gases – at the same conditions of pressure and temperature contain equal numbers of molecules according to Avogadro's postulate.

Answer: The correct choice is (d)

* Afterwards, Avogadro discovered that

at the standard conditions (at STP):

- A mole of any gas occupies 22.4 L volume.
- A mole of any gas contains
 6.02 × 10²³ molecules.

Standard conditions STI'

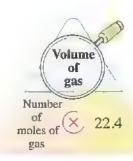
Standard Temperature and ressure
Which are:

- 0°C temperature = 273 K
- 1 atm pressure = 760 mmHg

* The relation between the number of moles

of gas and its volume (at STP) can be expressed as follows:

The volume of gas (L) = Number of moles of gas (mol) \times 22.4 (L/mol)



The following table illustrates the relation between the number of moles of gas,
 its volume and its number of molecules and atoms (at STP) for different gases :

Gas	He	O ₂	CO ₂	Ne	H ₂
Given mass In grams	4 g	16 g	22 g	5 g	0.5 g
Molar mass	4 g/mol	32 g/mol	44 g/mol	20 g/mol	2 g/mol
Number of moles (n)	$\frac{4}{4} = 1 \text{ mol}$	$\frac{16}{32} = 0.5 \text{ mol}$	$\frac{22}{44} = 0.5 \text{ mol}$	$\frac{5}{20} = 0.25 \text{ mol}$	$\frac{0.5}{2} = 0.25 \text{ mol}$
Volume (\forall) (at STP)	22.4 L	0.5 × 22.4	4 = 11.2 L	0.25 × 22	.4 = 5.6 L
Number of molecules	6.02 × 10 ²³ molecules		02×10^{23} molecules		02×10^{23} 0^{23} molecules
Number of atoms	6.02×10^{23} atoms	$6.02 \times 10^{23} =$		$\begin{array}{ c c } \hline 0.25 \times \\ 6.02 \times 10^{23} = \\ 1.505 \times 10^{23} \\ \hline \text{atoms} \end{array}$	

Worked Examples

What is the volume which is occupied by 39.2 g of nitrogen gas (at STP)?

 $\sqrt{N} = 14$

(a) 16 L

(b) 31.36 L

© 62.72 L

d 1.6 L

Idea of answering:

Molar mass of N_2 gas = $2 \times 14 = 28$ g/mol

Number of N₂ moles = $\frac{N_2 \text{ mass}}{N_2 \text{ molar mass}} = \frac{39.2}{28} = 1.4 \text{ mol}$

Volume of N_2 gas = Number of moles $\times 22.4 = 1.4 \times 22.4 = 31.36$ L

Answer: The correct choice is (b)

What is the mass of a sample of nitrous oxide gas N₂O which occupies

550 mL (at STP) ?

[N = 14, O = 16]

- (a) 1.08×10^3 g
- (b) 0.025 g
- © 5.68×10^{-4} g
- d) 1.1 g

Idea of answering:

Volume of
$$N_2O$$
 gas $-\frac{550}{1000} = 0.55 L$

Number of moles of
$$N_2O$$
 gas = $\frac{\text{Volume of gas}}{22.4}$

$$=\frac{0.55}{22.4}=0.025$$
 mol

Molar mass of
$$N_2O$$
 gas = $(2 \times 14) + 16 = 44$ g/mol

$$= 0.025 \times 44 = 1.1 g$$

Answer: The correct choice is (d)

3 Calculate the volume of oxygen gas (at STP) which is required for burning 2.6 g of

ethyne gas C₂H₂

[C = 12, H = 1]

Answer:

Molar mass of
$$C_2H_2$$
 gas = $(2 \times 12) + (2 \times 1) = 26$ g/mol

Number of moles of
$$C_2H_2$$
 gas = $\frac{C_2H_2 \text{ mass}}{C_2H_2 \text{ molar mass}} = \frac{2.6}{26} = 0.1 \text{ mol}$

$$2C_2H_{2(g)} + 5O_{2(g)} \xrightarrow{\Delta} 4CO_{2(g)} + 2H_2O_{(v)}$$

Number of moles of
$$O_2$$
 gas = $\frac{0.1 \times 5}{2}$ = 0.25 mol

Volume of
$$O_2$$
 gas = Number of moles $\times 22.4 = 0.25 \times 22.4 = 5.6 \text{ L}$

Chapter One

Methane gas burns completely forming carbon dioxide gas and water vapour, according to the equation :

$$\mathbf{CH}_{4(\mathbf{g})} + \mathbf{2O}_{2(\mathbf{g})} \xrightarrow{\Delta} \mathbf{CO}_{2(\mathbf{g})} + \mathbf{2H}_2\mathbf{O}_{(v)}$$

Which of the following expresses the reactants and the products in this reaction (at STP) ?

- (a) 1 mol of CH₄ gas contains Avogadro's number of atoms.
- (b) I mol of methane gas occupies a volume equals 12 L
- © The volume of the produced CO₂ gas equals double the volume of the consumed CH₄ gas.
- d The complete burning of 1 mol of CH₄ gas results in producing 67.2 L of gases and vapours.

Idea of answering:

- : Number of moles of the atoms in 1 mol of $CH_4 = 5$ mol
- :. Number of the atoms in 1 mol of CH₄ = 5 × Avogadro's number

 (i.e. 1 mol of CH₄ contains 5 times as Avogadro's number of atoms)
- : The choice (a) is excluded.
- : 1 mol of any gas occupies 22.4 L (at STP).
- ∴ The choice (b) is excluded.
- \because Number of moles of the produced CO_2 gas equals that of the consumed CH_4 gas.
- \therefore The volume of CO₂ gas equals that of CH₄ gas (at STP).
- : The choice (c) is excluded.
- : 1 mol of CH₄ gas produces on burning 3 mol of gases and vapours.
- \therefore Volume of the produced gases and vapours (at STP) = 3×22.4

= 67.2 L

Answer: The correct choice is d

Nitrogen gas reacts with oxygen gas according to the equation:

$$N_{2(g)} + 2O_{2(g)} \longrightarrow 2NO_{2(g)}$$

What are the volumes of the gases which remain in the reaction vessel (at STP) after the end of the reaction on mixing 50 mL of nitrogen gas with 50 mL of oxygen gas?

Choices	N _{2(g)}	$O_{2(g)}$	NO _{2(g)}
(a)	0	0	100 mL
(b)	0	25 mL	50 mL
©	25 mL	0	50 mL
<u>d</u>	25 mL	25 mL	50 mL

Idea of answering:

Volume of NO_{2(a)} produced on consuming

	-(E)		
	All N _{2(g)}	All C	$O_{2(g)}$
$N_{2(g)} = \frac{p}{2}$	roduces 2NO _{2(g)}	2O _{2(g)} prod	2NO _{2(g)}
1 mol	2 mol	2 mol	2 mol
$(22.4 \times 10^3) \text{ mL}$	$(2 \times 22.4 \times 10^3) \text{ mL}$	$(2 \times 22.4 \times 10^3) \text{ mL}$	$(2\times22.4\times10^3) \text{ mL}$
22400 mL	44800 mL	44800 mL	44800 mL
50 mL	? mL	50 mL	? mL
Volume of the p	roduced NO ₂ gas	Volume of the produce	ed NO ₂ gas
	$=\frac{50 \times 44800}{32400} = 100 \text{ mL}$	de la companya de la	$=\frac{50 \times 44800}{44800} = 50 \text{ mL}$

: Lower volume of NO2 is produced on consuming all O2

- ∴ O₂ is the limiting reactant of this reaction.
- : Volume of O₂ remaining in the reaction vessel = Zero
- : The choices (b) and (d) are excluded.
- : The produced volume of NO₂ gas = 50 mL
- : The choice (a) is excluded.

Answer: The correct choice is (c)



Test Yourself

According to the reaction: $Zn_{(s)} + 2HCl_{(aq)} \longrightarrow ZnCl_{2(aq)} + H_{2(g)}$ What is the produced volume of hydrogen gas when 12.04×10^{23} atoms of zinc react with excess of the acid?

(a) 22.4 L

(b) 44.8 L

© 11.35 L

(d) 68.1 L

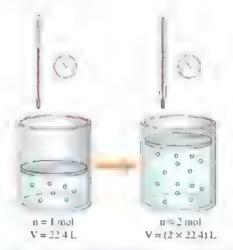
Idea of answering:

......

Answer:

The correct choice is

* The scientist Avogadro discovered the relation between the volume of gas and its number of moles, known as Avogadro's law which states that the volume of gas is directly proportional to the number of its moles at constant temperature and pressure.



45 40 35 35 30 25 20 15 10 0 0.25 0.5 0.75 1 1.25 1.5 1.75 2 Number of moles (mol)

The volume of gas is doubled by doubling its number of moles (n) at the same temperature and pressure

Worked Example

Two samples of oxygen and nitrogen gases have the same mass at the same conditions of pressure and temperature.

Which of the following is the ratio between $N_2: O_2$ volumes ?

$$a \frac{8}{7}$$

ⓑ
$$\frac{5}{3}$$

$$\bigcirc \frac{5}{6}$$

$$\frac{d}{2}$$

Idea of answering:

Molar mass of $N_2 = 2 \times 14 = 28$ g/mol

Molar mass of $O_2 = 2 \times 16 = 32$ g/mol

- * Assuming that the mass of each sample is x g, hence:
- Number of N₂ moles = $\frac{x}{28}$
- Number of O_2 moles = $\frac{x}{32}$
- .. The volume of gas is directly proportional to the number of its moles at constant temperature and pressure.

$$\therefore \frac{\text{Volume of N}_2 \text{ gas}}{\text{Volume of O}_2 \text{ gas}} = \frac{\text{No. of N}_2 \text{ moles}}{\text{No. of O}_2 \text{ moles}}$$

$$\therefore \text{ The volume ratio} = \frac{\frac{X}{28}}{\frac{X}{32}} = \frac{32}{28} = \frac{8}{7}$$

Answer: The correct choice is (a)

Pail Jumail

Two balloons have the same volume at the same conditions of temperature and pressure, one of them is filled with helium and the other with carbon dioxide gas. Do you expect that they both have the same mass?

Cuestions 9 12 - m - 3



Answer them yourself

Choose the correct answer:

- - $_{\rm d}$ 6.02 \times 10²³ molecules of H $_{\rm 2}$
 - b. 2 g of H₂
 - c. 12.04×10^{23} atoms of H
 - d. 1 g of H₂
- (2) Two samples of O_2 and H_2 gases have the same volume (at STP), they have equal
 - a. number of moles only.

b. masses.

 $\{H = 1, O = 16\}$

- c. number of molecules only.
- d. a. and c. together.
- (3) The volume of 4 g of hydrogen gas (at STP) equals

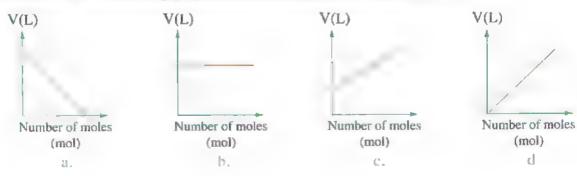
[][-]]

a. 89.6 L

b. 44.8 L

c. 22.4 L

- d 21.
- (4) The limiting reactant is the reactant which
 - a has the least mass.
 - b. has the least coefficient in a balanced equation.
 - c. has the least number of moles.
 - d. yields the least amount of the products.
- (5) Which of the following graphical figures represents Avogadro's law?



Give reasons for :

- (1) Number of atoms in 32 g of oxygen does not equal the number of atoms in 32 g of sulphur.
- (2) One mole of each of CO and CO₂ contains the same number of molecules despite the difference of their molecular masses.
- (3) Number of atoms in 6 g of carbon equals the number of molecules in 14 g of carbon monoxide. [C = 12, O = 16]
- (4) One liter of O2 gas contains the same number of molecules in 1 liter of Cl2 gas (at STP).
- (5) Volume of 1 mole of methane gas CH₄ equals the volume of 1 mole of ammonia gas NH₃ at the standard conditions.
- (6) The volume of 26 g of acetylene gas (C_2H_2) is equal to the volume of 2 g of hydrogen gas H_2 (at STP). [C = 12, H = 1]

Miscellaneous problems:

- (1) Calculate the number of molecules of CO2 in 0.5 mol of it.
- (2) Calculate the volume of 3.5 mol of O_2 gas (at STP).



Open book quintions

Answered -

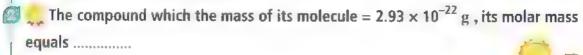




Mole and Avogadro's number of molecules

FR	What is th	ne number	of the	molecules	in a	sample	of a	mmonia	NH ₃	its mass	5
Ì	equals 43	.5 g ?									n

- [N = 14, H = 1]
- (a) 2.62×10^{25} molecules.
- (b) 2.36×10^{23} molecules.
- © 1.54×10^{24} molecules.
- 10^{-16} molecules.



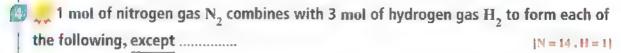
- a 2 g/mol
- (b) 567 g/mol
- (c) 168 g/mol
- (I) 176.4 g/mol



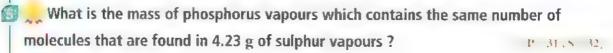
 ${\color{red} {\overline {33}}}$ What is the mass of one molecule of ethanoic acid ${\color{red} {\rm C_2H_4O_2}}$?

(12 , H = 1 , O = [6]

- (a) 0.1 g
- (b) 9.97×10^{-23} g
- (c) 3.6 × 10⁻²³ g
- (l) 60 g



- a 2 mol of NH₂
- (b) 34 g of NH,
- \bigcirc 2 × 6.02 × 10²³ molecules of NH,
- d 17 g of NH,



- (a) 2.046 g
- (b) 4.224 g
- © 8.184 g
- (d) 33.84 g

Mole and Avogadro's number of atoms

6	Number of the atoms in 0.5 mol of acetic acid CH ₃ COOH equals
	a Avogadro's number.
	b double Avogadro's number.
	© four times Avogadro's number.
	d eight times Avogadro's number.
7	What is the number of atoms of oxygen in 0.1 mol of CuSO ₄ .5H ₂ O ?
	(a) 5.42×10^{22} atoms. (b) 2.41×10^{23} atoms.
	© 6.02×10^{23} atoms.
8	Number of atoms in 1.25 mol of NO ₂ equals
Ī	(a) 22.575×10^{23} atoms (b) 18.06×10^{23} atoms
	(c) 3.75 atoms (d) 3 atoms
9	4 g of sodium hydroxide contaîn
ĺ	(a) 6.02×10^{23} atoms of H
	(b) 4 g of atoms of Na
	© 4 mol of NaOH
	(d) 6.02×10^{22} atoms of Na
500	
Ш	The number of atoms of phosphorus vapour in 100 g of it equals [P=31]
	(a) 1.94×10^{24} atoms. (b) 8.45×10^{25} atoms.
	© 4.85×10^{23} atoms.
4	**
	are present in 0.12 g of it, knowing that the diameter of carbon atom = 0.7 nm ? (-12)
	(a) 4.214×10^{21} m (b) 4.214×10^{12} m
	© $2.107 \times 10^{21} \text{ m}$
12	A sample of oxygen gas its mass is 32 g contains
	(a) 6.02×10^{23} oxygen atoms.
	(b) 1.204×10^{24} oxygen molecules.
	(c) the same number of oxygen atoms found in 18 g of water.

(1) the same number of oxygen atoms found in 36 g of water.

13 What is the gram mass of a sample of aluminum contains half Avogadro's number

of atoms?

- (a) 6.75 g
- (h) 13.5 g
- (c) 27 g
- (d) 54 g



 \square The blood of the adult person contains about 2.64 \times 10¹³ red blood cells, the mass of iron in them is 2.9 g

What is the number of iron atoms in each red blood cell?

|Fe 55.85

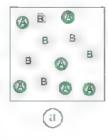
- (a) 0.118×10^{10} atoms.
- (b) 0.236×10^{10} atoms.
- (c) 6.02×10^{23} atoms.
- (d) 12.04×10^{23} atoms.

Mole and Avogadro's number of ions

- On dissolving 1 mol of sodium chloride in water completely, the total number of ions equals .. .
 - (a) Avogadro's number.
 - (b) 2 × Avogadro's number.
 - © 3 × Avogadro's number.
 - (d) 4 × Avogadro's number.

The limiting reactant

🌃 In which of the cases, illustrated in the following figures, (B) is considered the limiting reactant of the hypothetical reaction : $2A + B \longrightarrow C$?











oximes Phosphorus $\mathbf{P}_{\!\scriptscriptstyle A}$ can be prepared from the following reaction :

What is the limiting reactant of this reaction?

(a) C

- (b) Ca₃(PO₄)₂
- (c) SiO,

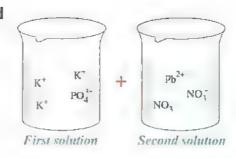
In the reaction: $AlCl_{3(aq)} + 3NaOH_{(aq)} \longrightarrow Al(OH)_{3(aq)} + 3NaCl_{(aq)}$

When 1 mol of aluminum chloride is added to 1 mol of sodium hydroxide.

What is the number of moles of the substance remaining at the end of the reaction?

- (a) 1 moi
- $\frac{1}{2}$ mol
- $\frac{2}{2}$ mol
- (1) $\frac{1}{4}$ mol

🔟 🔙 On mixing the two solutions which are illustrated in the opposite figure, a precipitate is formed. What is the number of moles of the formed precipitate when 6 mol of the first solution reacts with 4 mol of the second solution?



- (a) 4 mol
- (b) 3 mol
- (c) 2.3 mol
- (d) 1.33 mol

Avogadro's postulate

Two balloons have the same volume (at STP), the first is filled with helium gas, and the other with argon gas.

Which of the following statements represents correctly both of them?

- (a) Helium balloon contains higher number of atoms than argon balloon.
- (b) Helium balloon contains lower number of atoms than argon balloon.
- () Helium balloon contains the same number of atoms as argon balloon.
- (d) Helium balloon has higher mass than argon balloon.

Mhich of the following is an application of Avogadro's postulate?

[C = 12.11 = 1]

- ... 11.2 L of O₂ gas contains the same number of molecules found in 11.2 L of H₂ gas.
- (b) 1 liter of Cl, gas contains the same number of atoms found in 1 liter of SO₂ gas.
- The volume which is occupied by 26 g of C₂H₂ gas is larger than that occupied by 2 g of H₂ gas.
- The volume of 1 mol of CH₄ gas is lower than the volume of 1 mol of NH₃ gas.

Which of the following is an application of Avogadro's postulate?

- a Oxygen atom is 16 times heavier than hydrogen atom.
- (b) 1 cm³ of each of Ar, O₂ and NH₃ gases contains the same number of molecules at 80 K and 1 atm.
- Volume of hydrogen gas increases by increasing its number of moles at constant temperature and pressure.
- d A mole of any gas such as CH₄ gas contains 22.4 L (at STP).

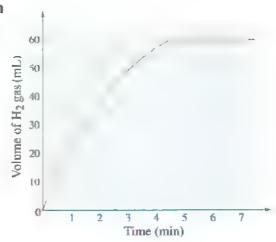
Mole and the volume of gas

The opposite graph represents the relation between the volume of H₂ gas which evolves (at STP) on the reaction of a given amount of zinc completely with excess of dilute hydrochloric acid with time.

What is the time which is consumed in the reaction of half of the amount of zinc?



- (b) 4.5 min
- © 2.25 min
- (d) 1.5 min



- The gas which the volume of 0.6 g of it = 80 mL (at STP), its molar mass =
 - (a) 340 g/mol
- (b) 310 g/mol
- © 168 g/mol
- (d) 85 g/mol

₫ Wh	at is the mass of 0.2	5 L of the gas (X) (at STP) who	ose molar mass	= 62.7 g/mol ?	
(a)	0.69 g	(b) 0.35 g				
0	0.07 g	d 0.035 g				
26 The	e largest mass of oxy	gen gas among	the following	is the mass of	0 - 10	F
a	1 molecule	(b) 11.2 L				
(C)	1 mol	d 1 atom				
The The	volume of 12.04 ×	10 ²³ molecules	of hydrogen ga	s (at STP) equa	ls	
	89.6 L	(b) 44.8 L				
(2)	22.4 L	(d) 2 L				
28 🚚	Here are four identi	cal flasks which	contain equal	amounts of diff	ferent gases	
at t	he same conditions	of temperature	and pressure.			
Wh	ich of these flasks is	the largest in n	nass ?	[Ne=20], ($\simeq 12$,	H = 1 , $O = 16$, $N = 14$	1
Neon -		thane C ₂ H ₆	Oxygen		Nitrogen	
	(a)	b		©	d	
29 Acc	ording to the reaction	on:	2NO _(g) + O _{2(g)}	≥ 2NO _{2(g)}	3	
Wh	at is the volume of M	NO ₂ gas which i				
	gas with excess of	_				
(a)	10 mL	(b) 15 mL				
0	20 mL	(d) 30 mL				
30 The	volume of hydroger	n which is requi	red to produce	11.2 L of wate	r vapour	
(at	STP) equals	· » #				
a	68.2 L	(b) 11.2 L				
(0)	44.8 L	(d) 22.4 L				
🛈 Who	en 14 g of CO gas re	eact with excess	of oxygen, the	volume of CO	gas which is	
	duced equals (at STP				[C = 12, O = 16]	1
(a)	89.6 L	(b) 11.2 L				
(0)	44.8 L	(d) 22 4 L				

$$Mg_{(s)} + 2HCl_{(aq)} \longrightarrow MgCl_{2(aq)} + H_{2(g)}$$

What is the mathematical relation of the calculation of the volume of evolving hydrogen gas (at STP)? [Mg = 24]

(a) $\frac{0.3 \times 2.24}{24}$ L (b) $\frac{0.3 \times 22.4}{24}$ L

 $\bigcirc 0.3 \times 24 \text{ L}$ $\bigcirc 0.3 \times 224 \text{ L}$

According to the reaction :

 $2SO_{2(g)} + O_{2(g)} \longrightarrow 2SO_{3(g)}$

If you know that atmospheric air contains 20% by volume oxygen gas. What is the volume of atmospheric air (at STP) which is required to react with 10 L of SO, gas?

(a) 2 L

(b)5L

🔯 🚚 20 mL of CO gas burn in 40 mL of $\mathrm{O_2}$ gas in a closed vessel according to

the equation:

 $2CO_{(p)} + O_{2(p)} \xrightarrow{\Delta} 2CO_{2(p)}$

What is the total volume of the gases (at STP) in the vessel after the end of the reaction?

(a) 20 mL

(b) 40 mL

© 50 mL

(d) 80 mL

Which of the following is the sum of the volumes of the gas and the vapour (at STP) produced from burning 5 g of methane gas CH₄?

(a) 5 L

(b) 7 L

(14 L

(d) 21 L

🜃 🌉 Two closed vessels contain chlorine gas at the same conditions of temperature and pressure,

so if the first vessel whose volume = 1.3 L contains 6.7 mol of gas.

What is the number of moles in the second vessel whose volume = 2.33 L?

(a) 0.452 mol

(b) 3.74 mol

(c) 12 mol

(d) 20.3 mol

Avogadro's law

Which of the following examples is an application of Avogadro's law?

- When 3 balloons contain equal numbers of H₂, O₂ and Cl₂ molecules, their volumes will be equal at the same temperature and pressure.
- 1) The balloon which contains H₂ gas, its volume increases by increasing temperature at constant pressure.
- The volume of a balloon decreases with decreasing the number of moles of Ar gas in it at constant temperature and pressure.
- ① The volume of a piston which contains neon decreases by increasing the pressure at constant temperature.



Mole and Avogadro's number

3 Calculate the mass of sodium carbonate which contains 1.773×10^{17} carbon atoms.

[Na = 23, C = 12, O = 16]

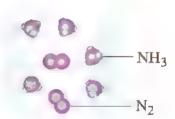
Calculate the mass of 100 atoms of copper (in grams).

[Cu 63.55]

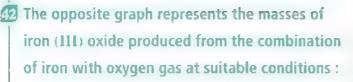
The limiting reactant

- In the reaction: $4NH_{3(g)} + 5O_{2(g)} \longrightarrow 4NO_{(g)} + 6H_2O_{(v)}$ Conclude the limiting reactant of the reaction on mixing 2 g of ammonia gas with 6 g of oxygen gas in suitable conditions for the reaction.

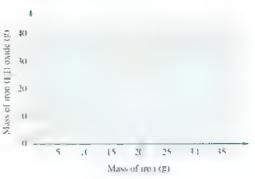
 [N = 14, H = 1, O = 16]
- The opposite figure represents the produced substances and the remaining unreacted substances on mixing hydrogen gas with nitrogen gas under suitable conditions for the reaction.



- (1) What is the limiting reactant in this reaction?
- (2) What is the number of the molecules of the limiting reactant in this reaction which are required to be added to the reaction mixture, so that all the reactants are consumed?



- (1) Write the balanced symbolic chemical equation which represent this reaction.
- (2) What is the limiting reactant of this reaction? Explain.



Avogadro's postulate

4 balloons are inflated with four different gases at the same conditions of temperature and pressure, the mass of :

- Hydrogen gas in the first balloon was 0.02 g
- Helium gas in the second balloon was 0.04 g
- Neon gas in the third balloon was 0.2 g
- Oxygen gas in the fourth balloon was 0.32 g

Arrange these balloons according to their volumes, explain your answer with chemical calculations. [H = 1, He = 4, Ne = 20, O = 16]

Mole and the volume of gas

Sodium carbonate reacts with hydrochloric acid, according to the equation:

$$Na_2CO_{3(s)} + 2HCl_{(aq)} \longrightarrow 2NaCl_{(aq)} + H_2O_{(f)} + CO_{2(g)}$$

Calculate the volume of CO₂ gas (at STP) which is produced from the reaction of 0.02 mol of sodium carbonate with excess of hydrochloric acid.

In the reaction of 11.5 g of sodium with excess of water according to the equation: $2Na_{(s)} + 2H_{(s)} \longrightarrow 2NaOH_{(aq)} + H_{2(e)}$

- (1) Calculate the volume of hydrogen gas (at STP) which is produced from this reaction.
- (2) Calculate the number of sodium ions which are produced from this reaction.

[Na = 23, H = 1]

Is gas (X) oxygen gas O_2 or methane gas CH_4 ? Explain.

New types of questions ?____

Choosing	two	out	of	five choices	questions :	
		A 22.2	•	HING GIIGICCA	decamons.	я

1	In the reaction:	CaCO _{3(s)} +	2HNO _{3(aq)}	Ca(NO ₃) _{2(aq)}	+ H ₂ O _(l) +	CO _{2(g)}
---	------------------	------------------------	-----------------------	---------------------------------------	-------------------------------------	--------------------

0.08 mol of nitric acid is added to 0.05 mol of calcium carbonate. Which of the following is correct after the end of the reaction?

- (a) 0.05 mol of CO₂ is produced.
- (b) 0.08 mol of Ca(NO₃)₂ is produced.
- © 0.01 mol of CaCO₃ remains unreacted.
- d 0.03 mol of HNO₃ remains unreacted.
- © 0.04 mol of H₂O is produced.
- The following equation is not balanced:

.....
$$Zn + HNO_3 --- Zn(NO_3)_2 + NO + H_2O$$

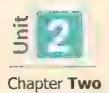
After balancing the equation, it will be clear that

- a) the number of moles of HNO3 equals the number of moles of H2O
- (b) the number of moles of nitrate group is the same in both the reactants and the products.
- © on mixing 6 mol of Zn with 12.5 mol of HNO3, all the acid is consumed.
- (d) on mixing 3 mol of Zn with 6 mol of HNO₃, all zinc is consumed.
- (e) the number of moles of zinc equals the number of moles of Zn(NO₃)₂
- There are 3 samples of different gases at the same conditions of temperature and pressure :
 - (1) 5 g of neon gas.
- (2) 2 g of hydrogen gas.
- (3) 22 g of carbon dioxide gas.

Which of the following represents correct relations between the volumes of these gases ? [Ne = 20, H = 1, C = 12, O = 16]

- (a) Volume of sample (1) = volume of sample (2).
- (b) Volume of sample (2) = volume of sample (3).
- © Volume of sample (2) > volume of sample (3).
- (d) Volume of sample (3) > volume of sample (1).
- e) Volume of sample (2) < volume of sample (1).
- Two samples, one of them is of ethylene gas C₂H₄ and the other is of nitrogen gas at the same conditions of temperature and pressure, they both contain the same number of molecules with the same
 - volume.
- (b) mass.
- c number of moles.

- d number of atoms.
- e molar mass.



Calculation of chemical formula





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- * The term "mass percentage" is used in chemical calculations, to calculate the percentage of each component in a given sample, by:
 - Knowing the molecular formula of the compound, and by knowing the gram atomic masses of the elements composing this compound

For illustration



Law of definite proportions

states that each chemical compound will always contain the same proportion of elements by mass, whatever the method of its preparation was.

from the relation:

Mass percentage of an element in a compound = $\frac{\text{Mass of the element in a mole of the compound}}{\text{Molar mass of the compound}} \times 100\%$

· Experimental results which are obtained practically, from the relation:

Mass percentage of an element in a sample = $\frac{\text{Mass of the element in the sample}}{\text{Mass of the sample}} \times 100\%$

* The sum of the percentages of the elements composing the compound must equal 100%

Worked Examples

Calculate the mass percentages of the components of potassium sulphate salt.

1K = 39 , S = 32 , O = 161

Answer:

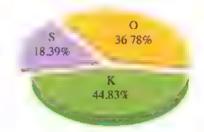
$$K_2SO_4$$
 contains $2K + S + 4O$
 $((2 \times 39) + 32 + (4 \times 16))g$ $(2 \times 39)g$ $32g$ $(4 \times 16)g$
 $174g$ $78g$ $32g$ $64g$

Mass percentage of an element in a compound = $\frac{\text{Mass of the element in a mole of the compound}}{100\%}$ Molar mass of the compound

Mass percentage of K in
$$K_2SO_4 = \frac{78}{174} \times 100\% = 44.83 \text{ a}$$

Mass percentage of S in
$$K_2SO_4 = \frac{32}{174} \times 100\% = 18.39\%$$

Mass percentage of O in
$$K_2SO_4 = \frac{64}{174} \times 100\% = \frac{64}{174}$$



To check the correctness of the calculations:

The sum of the percentages of all components = 44.83 + 18.39 + 36.78 = 100%

Which of the following compounds has the highest mass percentage of hydrogen?

(a) HCI

- (b) H₂O
- [H = 1, Cl = 35.5, O = 16, S = 32]

C H2SO4

d H,S

Idea of answering:

Choices	Molar mass of the compound	Mass percentage of hydrogen in the compound
(a)	1 + 35.5 = 36.5 g/mol	$\frac{1}{36.5} \times 100\% = 2.74\%$
b	$(2 \times 1) + 16 = 18 \text{ g/mol}$	$\frac{2}{18} \times 100\% = 11.11\%$
C	$(2 \times 1) + 32 + (4 \times 16) = 98$ g/mol	$\frac{2}{98} \times 100\% = 2.04\%$
<u>d</u>	$(2 \times 1) + 32 = 34 \text{ g/mol}$	$\frac{2}{34} \times 100\% = 5.88\%$

Answer: The correct choice is (b)

- 1 0.4 g of oxygen combines completely with 1.63 g of zinc to form zinc oxide, What is the mass percentage of oxygen in the product?
 - (a) 4%
 - (b) 16.3%
 - © 19.7%
 - d) 80.3%

Idea of answering:

Mass of the sample of zinc oxide = 0.4 + 1.63 = 2.03 g

Mass percentage of an element in a compound = $\frac{\text{Mass of the element in the compound}}{\text{Mass of the compound}} \times 100\%$

Mass percentage of oxygen in the compound = $\frac{0.4}{2.03} \times 100\% = 19.7\%$

Answer: The correct choice is ©

Mass percentage of carbon in the male hormone which is called testosterone is 79.167%, the mole of this hormone contains 19 mol of carbon atoms.

What is the molar mass of this hormone?

[C = 12]

- (a) 176.5 g/mol
- (b) 190.7 g/mol
- © 267.8 g/mol
- d 287.99 g/mol

Idea of answering:

Mass of carbon in the mole of the hormone = $19 \times 12 = 228$ g

Molar mass of the hormone = $\frac{\text{Mass of carbon in 1 mol of the hormone} \times 100\%}{\text{Mass percentage of carbon in 1 mol of the hormone}}$

$$=\frac{228 \times 100\%}{79.167\%}$$
 = 287.99 g/mol

Answer: The correct choice is d

Calculation of the street

* Chemical formulas are classified into three types, which are:

Empirical formula

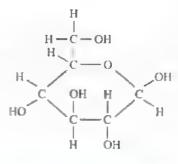
is the chemical formula which represents the simplest integer numerical ratio of the atoms or ions of the elements composing the compound CH,O

Molecular formula

Is a chemical formula which represents the types and the numbers of the atoms or ions which compose the molecule (or the formula unit) of the compound $C_6H_{12}O_6$

Empirical formula of glucose Molecular formula of glucose Structural formula of glucose

Structural formula



- * The empirical formula does not necessarily represent the chemical structure of the compound, as it is just a positive integer numerical ratio of the atoms or ions of the elements composing the compound, excluding some compounds whose empirical formulas are also their molecular formulas, such as CO and NO
- * The empirical formula of a compound can be calculated by knowing its molecular formula, by reducing the number of the atoms or ions which compose the molecule or the formula unit to the simplest possible form.

Worked Example

Which of the following represents an empirical formula as well as a molecular formula at the same time?

$$\bigcirc C_4H_8$$

$$(d) C_4 H_{10}$$

Idea of answering:

The empirical formula of each compound is calculated by reducing the number of the atoms which compose the molecule to the simplest form, as follows:

Answer: The correct choice is (a)

Calculation of the empirical formula

Worked Examples

formula of an organic compound formed of carbon and hydrogen elements only, if you know that the mass percentage of carbon in this compound is 85.72% and that of hydrogen is 14.28%

Idea of answering:

- * Assuming the mass of the compound is 100 g (to simplify the calculations), hence the mass percentage represents the gram mass of each element, therefore:
 - Mass of carbon in 100 g of the compound is 85.72 g
 - Mass of hydrogen in 100 g of the compound is 14.28 g
- Talculation of the number of moles of the atoms of each element:

Number of moles of element atoms =
$$\frac{\text{Mass of the element}}{\text{Gram atomic mass of this element}}$$

(2) Calculation of the ratio of the number of moles of the atoms of each element in one molecule of the compound, by dividing the number of moles by the smallest value of number of moles to find the simplest integer numerical ratio from which the empirical formula is estimated.

Answer:

C	Н
Number of moles of C atoms	Number of moles of H atoms
$=\frac{85.72}{12}=7.14 \text{ mol}$	$=\frac{14.28}{1}$ = 14.28 mol
Ratio of C moles number	Ratio of H moles number
$=\frac{7.14}{7.14}$	$=\frac{14.28}{7.14}$
= (1)	= 2
(C	H ₂

- What is the empirical formula of the sodium compound which is composed of 17.5% of sodium Na, 39.7% of chromium Cr and 42.8% of oxygen O?
 - (a) NaCrO₇ (b) Na₂CrO₇

Idea of answering:

Element	Na	Cr	0
Mass of the element in 100 g of the compound	17.5 g	39.7 g	42.8 g
Number of moles of element atoms	$\frac{17.5}{23} = 0.76 \text{ mol}$	$\frac{39.7}{52} = 0.76 \text{ mol}$	$\frac{42.8}{16} = 2.68 \text{ mol}$
Ratio of number of moles of the element atoms	$\frac{0.76}{0.76} = 1$	$\frac{0.76}{0.76} = 1$	$\frac{2.68}{0.76} = 3.5$
Simplest integer numerical ratio of number of moles of the element atoms (x 2)	1 × 2 = 12" :	1 × 2 = 2 :	$3.5 \times 2 = \widehat{\mathcal{I}}$
Empirical formula		Na,Cr,O,	

Answer: The correct choice is (c

Calculate the empirical formula of an organic compound composed of carbon, hydrogen and oxygen, knowing that by burning 2.3 g of a sample of this compound in excess of oxygen gas, 4.4 g of carbon dioxide gas and 2.7 g of water vapour are formed.

(C = 12, H = 1, O = 16)

Idea of answering:

- * Calculation of the mass of each of carbon and hydrogen elements in the sample by knowing the masses of CO₂ and H₂O produced from the burning process respectively.
- * Calculation of the mass of oxygen by subtracting the sum of the masses of H and C from the mass of the compound.



Answer:

$$CO_2$$
 contains C H_2O contains $2H$ $12 + (2 \times 16) = 44 g$ $12 g$ $(2 \times 1) + 16 = 18 g$ $(2 \times 1) = 2 g$ $4.4 g$ $? g$ $2.7 g$ $? g$

Mass of C in the sample =
$$\frac{4.4 \times 12}{44}$$
 = 1.2 g Mass of H in the sample = $\frac{2.7 \times 2}{18}$ = 0.3 g

:. Mass of O in the sample = Mass of the sample - (Mass of C + Mass of H)

$$= 2.3 - (1.2 + 0.3) = 0.8 g$$

Element	1	С		H	О
Mass of the element	1	1.2 g		0.3 g	0.8 g
Number of moles of element atoms	1	$\frac{1.2}{12}$ = 0.1 mol		$\frac{0.3}{1} = 0.3 \text{ mol}$	$\frac{0.8}{16} = 0.05 \text{ mol}$
Ratio of number of moles of the element atoms		$\frac{0.1}{0.05} = (2)$?	$\frac{0.3}{0.05} = 6$	$\frac{0.05}{0.05} = 1$
Empirical formula				C ₂ H ₆ O	

\bigcirc Hydrocarbon C_xH_y is burnt according to the following unbalanced equation :

$$C_x H_y + O_2 \xrightarrow{\Delta} CO_2 + H_2O$$

, so if you know that each 1 mol of this compound requires 5 mol of oxygen gas to be burnt producing 3 mol of carbon dioxide gas.

What is the chemical formula of this hydrocarbon mathematically?

$$\odot C_4H_8$$

Idea of answering:

$$C_xH_y + 5O_2 \xrightarrow{\Delta} 3CO_2 + H_2O$$

- : Number of moles of C atoms in the produced $CO_2 = 3$ mol
- \therefore The value of x in the hydrocarbon = 3
- : Number of oxygen atoms is 7 in the products and 10 in the reactants.
- .. The equation will be balanced by multiplying the coefficient of water \times 4

 The balanced equation: $C_xH_y + 5O_2 \xrightarrow{\Delta} 3CO_2 + 4H_2O$
- : Number of moles of H atoms in the produced $H_2O = 4 \times 2 = 8$ mol
- \therefore The value of y in the hydrocarbon = 8
- \therefore The chemical formula of the hydrocarbon is C_3H_8

Answer: The correct choice is (b)

Calculations of the molecular formula

Worked Example

Calculate the molecular formula of styrene, knowing that its molar mass is 104 g/mol and its empirical formula is CH [C=12,H=1]

Idea of answering:

① Calculation of the number of the units of the empirical formula (n), using the relation:

$$(n) = \frac{\text{Molar mass of the compound}}{\text{Molar mass of the empirical formula}}$$

2 Calculation of the molecular formula, using the relation:

Molecular formula = Empirical formula × n

Answer:

- Molar mass of the empirical formula CH = 12 + 1 = 13 g/mol

$$\therefore n - \frac{104}{13} = 8$$

- (CH)₈ C₈H₈





An unknown compound its molar mass is 60 g/mol, it is composed of carbon, hydrogen and oxygen elements in the percentages shown in the following table :

Element	Carbon	Hydro	ogen	Oxygen
Gram atomic mass	12 g	1 1	g	16 g
Mass percentage	40%	6.67	1%	53.33%

What is the molecular formula of this compound?

- a C₄H₈O
- (b) C₂H₈O₂
- © C2H4O
- $\bigcirc C_2H_4O_2$

Idea of answering:

Element	С	H	0
Number of moles of element atoms "mol"	= .	= 6.67 mol	 =
Ratio of moles number	= I	<u> </u>	=
Empirical formula		**********	
Molar mass of the empirical formula		,,,,,,,,,	
Number of units of the empirical formula		n = = 2	
Molecular formula			

Answer:

The correct choice is

Worked Examples

A chemical compound its empirical formula is CH₂O and each 0.0835 mol of it contains
 1 g of hydrogen.

What is the molecular formula of this compound?

$$(a)$$
 $C_2H_4O_2$

$$\textcircled{d} C_6 H_{12} O_6$$

Idea of answering:

$$(CH_2O)_n$$
 contains $2nH$ 0.0835 mol I g 1 mol $2nH$

- \therefore Mass of H atoms in the molecular formula of the compound = $\frac{1}{0.0835} \approx 12 \text{ g}$
- \therefore Number of moles of H atoms in the molecular formula of the compound = $\frac{12}{1}$ = 12 mol
- $\therefore 2n = 12$
- ... Number of units of the empirical formula (n) = 6
- :. Molecular formula of the compound $(CH_2O)_6 \Rightarrow C_6H_{12}O_6$

Answer: The correct choice is d

(A) and (B) are two compounds which are similar in the empirical formula but they differ in the molecular formula.

Conclude the reason which leads to the previous result.

Answer:

(A) and (B) are similar in the empirical formula as they are similar in the ratios between the numbers of the atoms of the elements forming the molecule of each of them, but they are different in the molecular formula as they have different molecular masses, and hence different numbers of units of the empirical formula.

Takminthe and the promontage of the mined place.

notation :

- The amount of the substance which is being obtained practically in the lab through this chemical reaction is known as the actual yield (or the practical yield or product).
- The amount of the substance which is expected to be obtained according to the mathematical calculations of the reaction equation is called the treoretical vicio.
- The actual yield is mostly less than the theoretical yield, this is due to a number of reasons, among which are:
 - Reactants may contain impurities.
 - The volatilization of a part of the products during the reaction.
 - Some side reactions may take place resulting in the consumption of a part of the products.
 - Sticking of a part of the products to the walls of the reaction container.
- The percentage of actual yield can be calculated from the relation:

The percentage of actual yield =
$$\frac{Practical (actual) yield}{Theoretical yield} \times 100\%$$

Worked Examples

f o Methyl alcohol ${
m CH_3OH}$ is prepared according to the reaction :

$$CO_{(g)} + 2H_{2(g)} \xrightarrow{\Delta} CH_3OH_{(\ell)}$$

Calculate the percentage of the actual yield of the reaction, if you know that when 1.2 g of hydrogen gas react with excess of carbon monoxide gas, they produce 6.1 g of methyl alcohol. |C=12|, H=1|, O=16|

Answer:

$$2H_{2(g)}$$
 $CH_3OH_{(\ell)}$
 $2(2 \times 1) = 4 \text{ g}$ $(12 + 3 + 16 + 1) = 32 \text{ g}$
 1.2 g $? \text{ g}$

The theoretical yield = $\frac{1.2 \times 32}{4}$ = 9.6 g

The percentage of the actual yield = $\frac{6.1}{9.6} \times 100\% = 63.54\%$



Molecule of methyl alcohol CH₃OH

- Ammonia gas reacts with excess of oxygen gas forming nitric oxide gas according to the equation: $4NH_{3(g)} + 5O_{2(g)} \longrightarrow 4NO_{(g)} + 6H_2O_{(y)}$, so if the mass of the actual yield of nitric oxide gas is 5 g and its percentage is 40% What is the mass of the reactant ammonia gas ? [N = 14, 11 = 1, 0 = 16]

Idea of answering:

The theoretical yield =
$$\frac{\text{Actual yield}}{\text{Percentage of actual yield}} \times 100\%$$

$$= \frac{5}{40\%} \times 100\% = 12.5 \text{ g}$$

$$4NH_{3(g)} \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad 4NO_{(g)}$$

$$4(14+3) = 68 \text{ g} \qquad \qquad \qquad \qquad \qquad 4(14+16) = 120 \text{ g}$$
? g
12.5 g

... Mass of ammonia gas =
$$\frac{68 \times 12.5}{120} = 7.08 \text{ g}$$

Answer: The correct choice is (a)

72 g of phosphorus oxide (P_4O_{10}) react with excess of water to form phosphoric acid according to the equation: $P_4O_{10} + 6H_2O \longrightarrow 4H_3PO_4$, so if the percentage of the actual yield is 70%

What is the mass of phosphoric acid which is actually produced? [H=1,P=31,O=16]

$$[H = 1, P = 31, O = 16]$$

Idea of answering:

$$P_4O_{10}$$
 $\xrightarrow{\text{produces}}$ $4H_3PO_4$ $((4 \times 31) + (10 \times 16)) = 284 \text{ g}$ $4((3 \times 1) + 31 + (4 \times 16)) = 392 \text{ g}$? g

The theoretical yield = $\frac{72 \times 392}{284}$ = 99.38 g

$$\therefore \text{ Mass of actual yield} = \frac{\text{Percentage of actual yield} \times \text{Theoretical yield}}{100\%} = \frac{70\% \times 99.38}{100\%} = \frac{69.566 \text{ g}}{100\%}$$

Answer: The correct choice is (d)

(1) When 25.57 g of nitrogen were mixed with 4.45 g of hydrogen at suitable conditions, a reaction took place, this reaction is represented by the following equation:

$$N_{2(g)} + 2H_{2(g)} \longrightarrow N_2H_{4(\ell)}$$

, so if the percentage of the actual yield is 82%

What is the actual yield of hydrazine N_2H_4 ?

[N = 14], H = 1

Idea of answering:

Molar mass of hydrazine = $(2 \times 14) + (4 \times 1) = 32$ g/mol

 N_2H_4 mass produced on consuming

All
$$N_{2(g)}$$
 produces $N_2H_{4(\ell)}$ $2H_{2(g)}$ produce $N_2H_{4(\ell)}$ $2H_{2(g)}$ $N_2H_{4(\ell)}$ $2H_{2(g)}$ $N_2H_{4(\ell)}$ $2H_{2(g)}$ $N_2H_{4(\ell)}$ $2H_{2(g)}$ $N_2H_{4(\ell)}$ $2H_{2(g)}$ $N_2H_{4(\ell)}$ $N_2H_{4($

- \because The lower mass of N_2H_4 is produced as a result of consuming all N_2
- :. N₂ is the limiting reactant of this reaction.
- \therefore The theoretical yield of $N_2H_4 = 29.2 g$

Actual yield = Percentage of actual yield × Theoretical yield 100%

 \therefore Actual yield of hydrazine $N_2H_4 = \frac{82\% \times 29.2}{100\%} = 23.94 \text{ g}$

Answer: The correct choice is a

Questions



Choose the correct answer:					
I hoose the correct answer:	Z=1				
WE CHILLSE THE COLLECT ANXWEL	I BOOCO	Tho	COPPOST	SINCIALOR	-
	V. HURLINGS	1111	COLLECT	CHINAREL	_

		Answer them yourself
Choose the correct a	answer:	ेल्यास्त्रस्य स्वयंत्रस्य प्रतेत्वसः चावतः गर्वतासः स्वयंत्रसः स्वयंत्रसः
(1) What is the mass pe	rcentage of chlorine in vanadinite who	ose molecular formula is
Pb ₅ (VO ₄) ₃ Cl ?	[Ph	0 = 207, $V = 50.9$, $O = 16$, $CI = 35.5$
a. 7.5%	b. 3%	
c. 2.5%	d. 1.13%	
(2) What is the mass pe	recentage of iron in iron (III) oxide?	Fe 55.86 (O = 16]
a. 0.72%	b. 28%	
c. 30%	d. 69.9%	
(3) The empirical form	ula of C ₄ H ₈ O ₂ is	
$a. C_4 H_4 O_2$	b. C ₂ H ₄ O	
c. C ₂ H ₈ O ₂	d. C ₄ H ₈ O	
(4) All the following co	empounds have the empirical formula	CH ₂ O, except
a. HCHO	b. CH ₃ COOH	
c. (COOH) ₂	d. $C_6H_{12}O_6$	
(5) What is the empiric	al formula of the compound whose mo	olecular formula
is $C_6H_3(NO_3)_3$?		
a. CHNO	b. C ₂ HNO ₃	
c. $(C_2HNO_2)_3$	$d. C_6H_3N_3O_6$	
(6) Number of units of	the empirical formula in $C_2H_2O_4 =$	
a. 1	b 2	
c.3	d. 4	
(7) If the empirical form	nula of a compound is CH2 and its mo	olar mass is 56 g/mol, so
its molecular formu	la is	$\{C = 12, H = 1\}$
a. C ₂ H ₄	b. С ₃ Н ₆	
c. C ₄ H ₈	d. C ₅ H ₁₀	

- - a. (CH)3OH
- b. C₆H₃O
- c. (CH₃)₂CO
- d. (CH₃)₂O
- (9) What is the percentage of the actual yield of zinc sulphate, if its calculated mass
 - = 1.358 g and its actual mass = 1.146 g?
 - a. 46%

b. 23%

c. 11.5%

d. 84.39%

Miscellaneous problems:

- (1) Calculate the mass percentage of iron in siderite ore $FeCO_3$ [1e = 56, C = 12, O = 16]
- (2) Calculate the molecular formula of a compound whose molecular mass is 34 g and its empirical formula is HO

 [El = 1, O = 16]
- (3) Calculate the molecular formula of a compound whose molar mass is 70 g/mol, knowing that it contains 85.7% of carbon and 14.3% of hydrogen. [C = 12.H 1]
- (4) 39.4 g of barium sulphate BaSO₄ are precipitated when an excess amount of potassium sulphate K₂SO₄ solution reacts with 40 g of barium chloride BaCl₂ solution. Calculate the percentage of the actual yield.
 18a = 137, C1 = 35.5, S = 32, O = 16



Open book questions

Answered





Culculation of the mass percentages of the components of a compound

1 29.3 g of the element (X) are separated from 660 kg of molybdenite ore.

What is the mass percentage of (X) in the ore?

0.0044%

(b) 0.0022%

© 0.0011%

- (d) 0.0001%
- In which of these compounds is the mass percentage of carbon the largest?
 - \bigcirc C₂H₂

(b) C₂H₄

 $^{\circ}$ C_3H_8

(d) C_4H_{10}



[C = 12, H = 1]

- These compounds are similar in all the following, except ...
 - CH₃CH₂CH₂COOH
 - · OHCCH2CH2CH2OH
 - CH₃CHCHCH₂SH

[C = 12, H = 1, O = 16, S = 32]

- d the mass percentage of carbon and hydrogen in each of them only.
- (b) their molar masses only.
- that each of them contains 3 elements only.
- d the number of atoms of the elements.
- One mole of a compound contains 5 mol of carbon atoms, and they represent 40% of the mass of the compound.

What is the molar mass of this compound?

[C=12]

(a) 30 g/mol

(b) 67 g/mol

© 150 g/mol

- (d) 210 g/mol
- A sample of hematite ore Fe₂O₃ its mass is 2.4 g, if the mass percentage of oxygen in it is 30.1%

What would be the mass of iron which can be extracted from it?

(a) 1.2 g

(b) 1.68 g

© 1.98 g

(d) 2.2 g

Calculation of the chemical formula

Which of the following shows both the molecular formula and the empirical formula of this opposite compound?

Choices	Molecular formula	Empirical formula
(a)	CH ₂ O	$C_2H_4O_2$
b	$C_4H_4O_4$	СНО
0	CH_2O_2	$C_4H_4O_4$
(b)	$C_2H_4O_2$	CH ₂ O

H \ c	O H
H ~ C	O H

- What is the empirical formula of the opposite compound?
 - $^{\circ}$ $C_{10}H_{8}$

(b) C₈H₄

 \bigcirc C₅H₄

 \bigcirc C_3H_2



- Which of the following compounds its empirical formula has the largest mass in grams?
 - \bigcirc C₆H₆

(b) C₄H₁₀

 $\bigcirc C_3H_6$

 $\bigcirc C_2H_6$

Calculation of the empirical formula

What is the chemical formula of the oxide of nitrogen which contains 63.64% by mass nitrogen?

[N = 14, O = 16]

[C = 12.H = 1,

a NO

(b) N₂O

© NO₂

- $\bigcirc N_2O_4$
- What is the empirical formula of the oxide of sulphur which contains 50% by mass sulphur? [S = 32.0 = 16]
 - \bigcirc SO₃

(b) SO₂

 \odot S₂O₄

- OS(b)
- What is the empirical formula of the hydrocarbon which contains 0.05 mol of carbon and 0.1 mol of hydrogen ?
 - (.) CH4

(b) CH₂

© CH

 \bigcirc C₂H



What is the em	npirical formula of the compound whi	ch is composed of
the elements X , Y	Y and Z in equal mass percentages?	[X = 20, Y = 40, Z = 60]
<u> </u>		

 $\bigcirc X_3Y_2Z$

(1) XY₂Z₃

© XYZ

 $(1) X_6 Y_2 Z_2$



• C = 72%

• H = 12%

• O = 16%



What is the ratio of the number of moles of carbon C: the number of moles of hydrogen (H) in the empirical formula of this compound? $\{C = 12, H = 1, O = 16\}$

(a) 1:1

(b) 1:2

(c) 1:6

(d) 6:1

An ionic compound is composed of 29.08% sodium, 40.56% sulphur and 30.36% oxygen.

What is the formula of sulphur ion in this compound?

[Na = 23, N = 32, O = 16]

(1) S₂O₂²

(b) S₂O₄²

() S₂O₅²⁻

(J) S202-

Calculation of the molecular formula

Which of the following represents a chemical compound whose molecular molar mass equals its empirical molar mass?

 $(a) C_6 H_6$

(b) N₂H₄

(c) H₂O₂

(d) N₂O₅

16 The molar mass of a compound = 88 g/mol

What is the probable empirical formula of this compound?

[C = 12.H = 1.O = 16]

by this mark

(a) CH₂

(b) CH2O

CH₃O

 $(d) C_2 H_4 O$

A compound contains 3 elements in the following percentages:

• C = 60%

· H = 8%

• O = 32%

What is the possible molecular formula of this compound?

(1) C₅H₂O₂

(b) C_5H_4O

C C6HO3

(d) C7HO4

 $\{C = 12, H = 1, O = 16\}$

1	3 2.4 g of element (X) combine	ed completely with 1.6 g of oxygen t	forming a compound
1	with the molecular formula	XO ₂	
1	What is the gram atomic ma	ss of the element (X) ?	O = 16
1	(i) 24 g/mol	(b) 27 g/mol	
!	© 35 g/mol	(d) 48 g/mol	
1	An organic compound with a	empirical formula CHCI, and its mo	lar mass = 291 g/mol
	What is the number of mole	s of carbon atoms in one mole of th	is compound ?
	1 mol of atoms.	(b) 3 mol of atoms.	[C = 12, H = 1, Cl = 35.5]
	© 6 mol of atoms.	(d) 12 mol of atoms.	
0	🛮 具 During the chemical anal	ysis of a hydrocarbon gas, it was fo	und that each carbon
	atom in it is binded to two h	ydrogen atoms.	
	What is the molecular formu	la of the gas, if its density equals 1.	.25 g/L ? (C) 11 - 1;
	(a) CH ₂	(b) C ₂ H ₄	
	© C ₂ H ₆	(I) C ₄ H ₈	
	Calculation of the percentag	e of actual yield	
0	11.9 g of CHCl ₃ react with	excess of chlorine gas to form 10.2	g of CCl ₄
	according to the equation :	$2CHCl_3 + 2Cl_2 \longrightarrow 2CCl_4 + 2HC$	1
	What is the percentage of th	ne actual yield ?	[0 - 12, H , et 388]
	(a) 100%	(b) 33.2%	
	© 66.5%	(d) 86%	
2	$^{\circ}_{2}$ 29 $_{\mathrm{g}}$ of butane gas $\mathrm{C_{4}H_{10}}$ at	re burnt in excess of oxygen gas for	ming 0.9 g of water
	vapour H ₂ O		
	What is the percentage of th	ne actual yield of water vapour?	U 12 H = 1 (O 16)
	(d) 0.02%	(h) 2%	
	© 10%	(d) 36%	
2	According to the reaction : ($C_6H_{12}O_6 \longrightarrow 2C_2H_5OH + 2CO_2$	
	On adding 100 g of yeast to	1 mol of $\mathrm{C_6H_{12}O_6}$, 32.3 g of $\mathrm{C_2H_5}$	OH are formed.
	What is the percentage of th	ne actual yield of C ₂ H ₅ OH ?	,c 12 ,H = I O [6]
	(1) 35.1%	(b) 17.5%	
	© 100%	(d) 32.3%	



23 \mathbf{M} What is the percentage of the actual yield of the reaction of 2.5 \mathbf{mol} of $\mathbf{Fe}(\mathbf{NO_3})_{\mathbf{A}}$ with 3.6 mol of Na₂CO₃ to form 6.3 mol of NaNO₃ according to the reaction:

$$2\text{Fe}(\text{NO}_3)_3 + 3\text{Na}_2\text{CO}_3 \longrightarrow \text{Fe}_2(\text{CO}_3)_3 + 6\text{NaNO}_3$$
?

- (a) 50%
- (b) 84%
- (c) 87.5%
- (1) 100%



One of the students added a solution which contains 1 g of silver nitrate to another solution which contains 1 g of sodium chloride, hence a precipitate of silver chloride was formed, when its mass (after washing and drying) was calculated, it was found to be 0.732 g

What is the percentage of the actual yield of silver chloride?

(a) 100%

- (b) 87.14%
- [Ag = 107.87, N = 14, O = 16, Na = 23, Cl = 35.5]

(c) 25.72%

d) 12.86%



On heating 20 g of an impure sample of $CaCO_3$ (its molar mass = 100 g/mol), 8.4 g of CaO (its molar mass = 56 g/mol) are produced.

What is the percentage of the purity of calcium carbonate?

(a) 15%

(b) 25%

(c) 55%

(d) 75%

27 \sum A mixture formed of 12 L of H_2 gas and 11.2 L of Cl_2 gas at suitable conditions for the reaction.

Which of the following is correct after the end of the reaction (at STP)?

Choices	Volume of formed HCl	Percentage of remaining unreacted substance
a	22.4 L	50%
b	24 L	50%
©	22.4 L	6.67%
d	24 L	6.67%

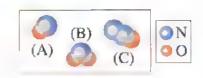


Coled now the a control or my the range one

Explain by chemical calculations which of the three compounds illustrated in the opposite figure contains

46.7% by mass nitrogen.

[N = 14, Q = 16]



Nitrogen gas N₂ reacts with hydrogen gas H₂ to form ammonia gas NH₃, so assuming that some of the units - in the opposite figure may react together forming ammonia.



Calculate the mass percentage of the remaining unreacted substance after the end of the reaction.

- When is the molecular formula of a compound also its empirical formula?
- Calculate the molar mass of the empirical formula of each of the following compounds:

$$[C = 12, O = 16, H = 1, Si = 28, Cl = 35.5]$$

$$(1) O = C = O$$

Calculation of the empirical formula

The mass of a sample of a certain compound = 80 g, this mass contains 32 g of sulphur and the rest of it is oxygen ..

Calculate the empirical formula of this compound.

1S = 32 , O = 16

Calculation of the molecular formula

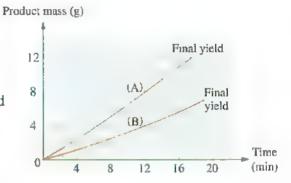
Deduce the molecular formula of a compound whose molar mass is 136 g/mol, and it consists of carbon, hydrogen and oxygen elements in the ratios which are illustrated in the opposite table.

Element	Gram atomic mass	Percentage
C	12 g	70.59%
H	1 g	5.89%
O	16 g	23.52%



Calculation of the percentage of actual yield

- What is wrong in saying that the actual yield of a compound is 24.2 g and its theoretical yield = 24 g?
- in the amounts of the susbstances which are produced from a given reaction :
 - (1) Which curve represents the theoretical yield and which represents the practical (actual) yield? Explain your answer.
 - (2) Calculate the percentage of the actual yield12 min after the beginning of the reaction.



in The following reaction is carried out at high temperatures:

$$2NH_{3(g)} + 3CuO_{(s)} \xrightarrow{\Delta} N_{2(g)} + 3Cu_{(s)} + 3H_2O_{(v)}$$

If 6.63 g of nitrogen gas are actually produced from the reaction of the mixture which is composed of 18 g of NH₃ and 90.4 g of CuO.

Calculate the percentage of the actual yield.

$$N = 14$$
 , $\Pi = 1$, $Cn = 63.5$, $O = 16$

The combustion reaction of carbon takes place according to the equation:

$$C_{(s)} + O_{2(g)} \xrightarrow{\Delta} CO_{2(g)}$$

Calculate the burnt mass of carbon in excess of oxygen, if the percentage of the actual yield = 89.3%, and the actual volume of CO_2 gas (measured at STP) equals 10 L

$$\{C = 12, O = 16\}$$

Choosing two out of five choices questions:

- Which of the following are empirical formulas?
 - a N₂O₄

(b) C₄H₈

© NH₃

(d) S₂O₆

- @ V₂O₅
- Which of the following salts loses 45% of its mass when all the water that is present in it is evaporated? $H_2O = 18. \text{ Na}_2SO_4 = 142. \text{ Co}_8O_4 = 159.8. \text{ Ni}_8O_4 = 154. \text{ KALSO}_2$, $= 258. \text{ Ni}_8SO_4 = 1201. \text{ Ni}_8O_4 = 1201. \text{$
 - (a) Na₂SO₄.10H₂O
 - (b) CuSO₄.5H₂O
 - © NiSO₄.7H₂O
 - (d) KAI(SO₄)₂.12H₂O
 - @ MgSO₄.7H₂O

Exam model

on Unit 2





Choose the correct answer for the questions (1): (









What is the volume of H, gas (at STP) which is produced from the reaction

of 12.15 g of magnesium with excess of hydrochloric acid?

[Mg + 24 . H = 1]

(a) 1 L

(b) 2 L

(c) 5.6 L

(d) 11.34 L

The opposite equation is not balanced: $S + HNO_3 \longrightarrow H_2SO_4 + NO_2 + H_2O$ What is the coefficient of water in the balanced equation?

(a) 1

(b) 2

(c) 4

(d) 6

Which of the following contains the highest number of molecules?

(a) 1 g H,

6) 2 g N₂

[H=1, N=14, O=16, C=12]

© 4 g O,

(d) 11 g CO.,

What is the empirical formula of arsenic oxide in which the percentage of arsenic (As) equals 65.2% ? [As = 75, O = 16]

(a) As₂O

(b) As,O,

C As₂O₅

(d) As₄O₁₀

What is the molar mass of potassium dichromate $K_2Cr_2O_7$?

[K = 39, C) = 52, C = 16]

- (a) 107 g/mol
- (b) 255 g/mol
- (c) 294 g/mol
- (d) 242 g/mol

In the reaction : $K_2CO_{3(s)} + 2HNO_{3(aq)} \longrightarrow 2KNO_{3(aq)} + H_2O_{(f)} + CO_{2(g)}$ What is the number of moles of carbon dioxide which are produced from the reaction of 69 g of potassium carbonate with excess of nitric acid?

- (a) 0.25 mol
- (h) 0.5 mol

© I mol

d) 2 mol

What i

What is the mass of 3.01×10^{23} atoms of sodium ?

[Na = 23]

(a) 46 g

(h) 23 g

© 11.5 g

(d) 0.5 g

(W) Hydrog

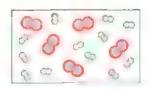
Hydrogen gas reacts with oxygen gas

according to the equation:

$$2H_{2(g)} + O_{2(g)} \longrightarrow 2H_2O_{(v)}$$

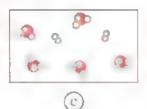
If you have the mixture which is shown in the opposite figure.

What would be the correct choice which represents the produced mixture after the end of the reaction?











1

On burning 50 mL of the hydrocarbon C_xH_y in excess of oxygen gas, 200 mL of carbon dioxide gas and 250 mL of water vapour are formed (at STP).

What is the molecular formula of this hydrocarbon?

(1) C₂H₄

(b) C₃H₈

C C4H8

 \bigcirc C_4H_{10}

n the reaction :

$$Mg_3N_{2(s)} + 6H_2O_{(I)} \longrightarrow 3Mg(OH)_{2(s)} + 2NH_{3(g)}$$

If the percentage of the actual yield = 80%

What is the mass of ammonia $\mathrm{NH_3}$ which can be prepared from 19 kg of $\mathrm{Mg_3N_2}$?

(1) 2.6 kg

[Mg = 24, N = 14, H = 1]

(h) 6.46 kg

© 5.17 kg

(d) 15 kg

" Alexander Alexander	es of andium in the symple (3	s of this area.	hasa was a
aculate the ma:	ss of sodium in the sample (\)	Tot this compound w	mose mass = 1
** ** * * * * * * * * * * * * * * * * *		,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	
4 414 454 E	** * *		

	** * * * * * * * * * * * * * * * * * * *		(
		** * ****	
		****	* (********************

** ***** ** *			
he following eq			(s)
he following eq S 1) Rewrite the pr	uation is not balanced .	→ KNO _{3(aq)} + SrSO ₄	(s)



Conclude the molecular formula of the compound whose molar r	mass is 78 g/mol and
its empirical formula is NaO	[Na = 23 , O = 16]
	44 +00++40133100
	1 mark
The molar mass of dibromoethane C ₂ H ₄ Br ₄ is 188 g/mol , this com an insecticide.	pound is used as
Calculate the mass percentage of bromine in this compound.	$\mathrm{He} = \mathrm{S0}$
	Imark
Calculate the number of hydrogen atoms in 1 mol of (NH ₄) ₂ HPO ₄	
	1 mers
The following symbolic equation represents the reaction of aluminu	ım with sulphur to
form aluminum sulphide: $16Al_{(+)} + 3S_{8(+)} \longrightarrow 8Al_2S_3$	3(s)
Write the physical state of each of aluminum and sulphur in the	previous equation.
	Lucis



Solutions, Acids and Bases

Lesson 7

Solutions and Colloids.

From The beginning of the chapter.

Until Before concentrations of solutions.

From Concentrations of solutions.

Until Before colligative properties of solutions.

From Colligative properties of solutions.

Until Before mixtures properties.

From Mixtures properties.

Until The end of the chapter.

Acids and Bases.

From Uses of acids and bases.

Until Before Classification of acids and bases.

From Classification of acids and bases.

Until Before salts.

From | Salts.

Until The end of the chapter.

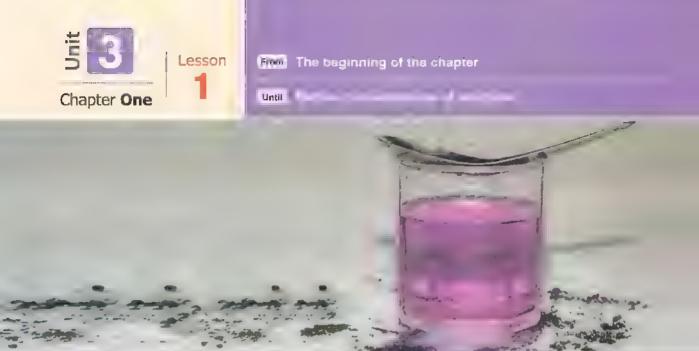
Exam model on the unit

Learning outcomes of unit three

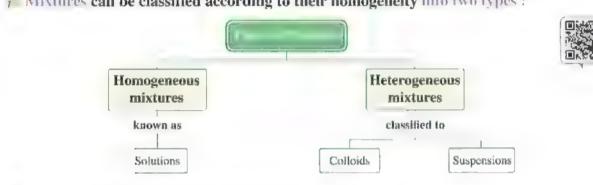
By the end of this unit, the student will be able to:

- Explain what is meant by solution and distinguish between the types of solutions by practical experiments
- Describe the solubility process, the factors affecting it and the heat changes accomplished with it
- Show the concentration of solutions using different methods.
- Calculate the concentration of the solution using one of the concentration units.
- Identify the general properties of solutions "solid in liquid".
- Represent the graphical relationship between the concentration of solution, the vapor pressure, the change in its boiling and freezing points.
- Compare between the colloid solutions and the real solutions in terms of the size of their compositions.
- Prepare some simple colloids and show their importance in our everyday life.
- Explain what is meant by acid and base and their classifications.
- Compare between the different theories to define the acid and the base
- Distinguish between acids and bases using indicators and the pH-meter.
- Understand how salts are formed, their naming and the pH values of their solutions.

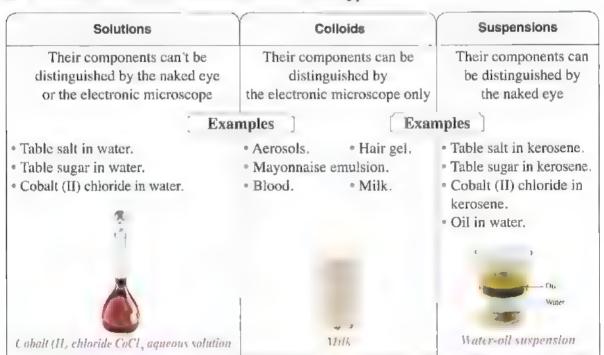
▶ The included life topic: Rationalization of consumption.



Mixtures can be classified according to their homogeneity into two types:



† This table shows the differences between these types :



Hamogeneous mixtures (Solutions)

* If a small quantity of a substance (as sugar) is added to a large amount of another substance (as water) and disappears in it.

Therefore:

- Sugar is a solute,
- · Water is a solvent.
- The produced mixture is a solution.

Solute

The minor component that has the lower ratio in the solution.

Solvent

The major component that has the larger ratio in the solution.

Solution

It is a homogeneous mixture of two or more substances which are chemically unreacted.



Solution composed of solvent and solute

Note

In aqueous solutions, water is always the solvent regardless its quantity (proportion) in the solution

- * When two samples of one solution are analyzed, it will be found that they contain the same contents in the same ratios, which proves the homogeneity of the solution, for example the sweet taste of sugar solution in water is the same in all of its parts, because of the homogeneity of the sugar solution, as each part of the solution contains the same amount (concentration) of sugar.
- * Solutions are necessary in the biological processes that occur inside the living organisms, they may be an essential requirement for the occurrence of certain chemical reactions.

Types of solutions

Solutions can be classified according to:

The physical state of the solvent.

The ability to conduct electricity.

The degree of saturation.



The solutions are divided into

A Gaseous solutions.

B Liquid solutions.

Solid solutions.

The following table shows some examples of these different types:

Types of solutions	Solute	Solvent	Examples
Gaseous solutions	Gas	Gas	Atmospheric air. Natural gas.
	Gas	Liquid	Soft drinks. Oxygen dissolved in water.
Liquid solutions	Liquid	Liquid	Alcohol in water. Ethylene glycol (antifreeze) in water.
	Solid	Liquid	Sugar in water. Salt in water.
Solid solutions	Gas	Solid	Hydrogen gas on palladium or platinum
	Liquid	Solid	Liquid mercury dissolved in solid silver (silver amalgam) $Ag_{(s)}/Hg_{(\ell)}$
	Solid	Solid	Alloys such as nickel-chromium (nichrome) alloy

For illustration

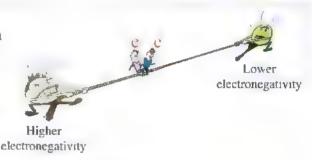


Mercury forms with solid metals such as silver, gold or platinum a kind of solution known as metal amalgam

* Our study will focus on (solid in liquid) type of solutions, in which water is always the solvent.

Quinting in the Land

- Electronegativity: It is the ability of an atom to attract the electrons of the bond to itself.
- Polar bond: It is the covalent bond between two atoms which are different in electronegativity, the higher electronegative atom carries a partial negative charge (δ), while the other atom carries a partial positive charge (δ⁺).



The atom with higher electronegativity attracts the electrons of the bond

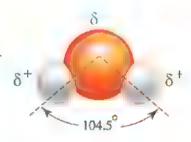
- Polar molecules: They are the molecules that
 have an end carrying a partial positive charge (δ⁺)
 and another end carrying a partial negative charge (δ̄⁻).
- δ⁺H Cl δ⁻

 Polar HCl molecule

- The degree of polarity depends on :
- Difference in electronegativity between the bonded atoms.
- Geometry of the molecule.
- Bond angles.

Water as a polar solvent

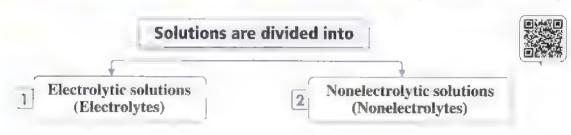
- Water is a polar solvent, because water molecule has
 one end carries a partial negative charge δ⁺ (oxygen),
 and the other end carries a partial positive charge δ⁺ (hydrogen).
- * Water is the most powerful polar solvent due to the presence of two polar (O H) bonds in each molecule, this is because of the high electronegativity of oxygen (much more than hydrogen), as well as the wide angle between these two bonds (104.5°).



Water H₂O is a polar molecule

democing to the ability to consist electricity

Solutions of substances are divided into two types according to the ability to conduct electricity.





Electrolytes

Are substances whose solutions (or moltens) can conduct electricity by the movement of the nydrated (or the free) ions.

Electrolytes are divided into:

Strong electrolytes

Are substances which are completely ionized and conduct electricity strongly



Strong electrolytes conduct electricity to a great extent



Hydrochloric acul is completely ionized

Completely ionized substances

are substances in which all their molecules are dissociated into ions when they dissolve in water

Weak electrolytes

Are substances which are partially ionized and conduct electricity weakly



Weak electrolytes conduct electricity to a weak extent



Acetic acid is partially ionized

Incompletely ionized substances

are substances in which a small part of their molecules are ionized into ions when they dissolve in water

Examples]

- Ionic compounds like :
 - Sodium chloride NaCl
 - Sodium hydroxide NaOH
 - * Polar covalent compounds like :
 Hydrochloric acid HCl_(aq),
 (which is produced when
 hydrogen chloride gas HCl_(g)
 dissolves in water).
- Ammonium hydroxide NH₄OH (ammonia in water).
- Acetic acid
 CH₃COOH
- Pure water H₂O

Notes

- * All organic acids are weak electrolytes.
- * All solid salts the electricity, while when they dissolve in water (as NaCl_(s)) (i.e. being in aqueous solution form as NaCl_(aq)), then they electricity.
- * All gases under normal conditions of temperature and pressure do not conduct electricity.



* Hydrogen chloride gas HCl_(g) does not conduct electricity, while when it dissolves in water it forms hydrochloric acid HCl_(aq) which is a good electric conductor, this dissolving process is represented by the following equation:

$$H_2O + HCl_{(g)} \longrightarrow H_3O^{\dagger}_{(aq)} + Cl_{(aq)}$$

 H^+ ions bind with water molecules forming hydronium ions $H_3O^+_{(aq)}$ (hydrated protons).

$$H_2O_{(\ell)}$$
 + $H_{(aq)}^+$ \longrightarrow $H_3O_{(aq)}^+$

Nonelectrolytes

Are substances whose solutions or moltens do not conduct electricity, as they have no free or hydrated ions.

Examples

- * Ethyl alcohol.
- * Sugar solution.



Nonelectrolytes
(Do not conduct electricity)

Warked Example

The opposite graphical figure shows the percentages of the electrical conductivity of 4 different solutions, (with no particular order):

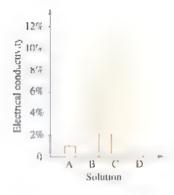
Glucose.

Sodium chloride.

Acetic acid.

Sodium carbonate.

Which of the following represents each of the solutions (A), (B), (C) and (D)?



Choices	Solution (A)	Solution (B)	Solution (C)	Solution (D)
(a)	Acetic acid	Sodium chloride	Sodium carbonate	Glucose
ь	Sodium carbonate	Acetic acid	Glucose	Sodium chloride
(c)	Glucose	Sodium chloride	Acetic acid	Sodium carbonate
(d)	Sodium chloride	Acetic acid	Sodium carbonate	Glucose

Idea of answering:

- : Glucose (a sugar in water solution) is a nonelectrolytic solution which does not conduct electricity.
- Solution (D) represents glucose.
- .. The choices (b) and (c) are excluded.
- : Acetic acid is an incompletely ionized substance which conducts electricity poorly.
- : Solution (A) represents acetic acid.
- : The choice (d) is excluded.

Answer: The correct choice is (a)



According to the degree of saturation

Solutions are divided into

Unsaturated solution

Saturated solution

Supersaturated solution

Unsaturated solution is the solution which contains a relatively small amount of the solute and can accept larger amount of this solute at a constant temperature.



Saturated solution is the solution which contains the maximum amount of the solute that can be dissolved at a certain temperature.

Supersaturated solution is the solution which by heating accepts larger amount (than the maximum) of the solute after being saturated.

* It is possible to convert :

- Saturated solution to supersaturated solution, by heating the saturated solution and adding more solute to it.
- @ Supersaturated solution to saturated solution, by two methods, which are:
 - a. Cooling: Cool the supersaturated solution and leave it for a short time, the excess solute will be separated (precipitate) from the solution.
- b. Crystals: Put small crystals from the solute in the supersaturated solution and leave it for a short time, the solute molecules will be precipitated as crystals on the surface of the seeding crystals.

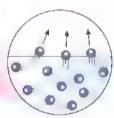


Formation of crystals from supersaturated solution

Plaselving process

- * Although water seems to be static in the beaker, but its molecules are really in a continuous motion, especially the surface molecules (by the effect of their kinetic energy).
- * When a solute is added to water, dissolving occurs as follows:





Water molecules are in a continuous motion

If the solute is

Ionic substance

Polar substance

So the particles of the solute dissociate during the dissolving process into:

positive and negative ions

polar molecules

which bind to the molecules of the solvent

- * In the light of the previous, dissolving process can be defined as follows:
- * Dissolving process is the process that occurs when the solute decomposes or dissociates into negative and positive ions or into separated polar molecules.

 Each of them binds to the molecules of the solvent.

Dissolving of sodium chloride NaCl in water:

- * When a crystal of sodium chloride is placed in water, the following occurs:
 - The polar water molecules collide with the crystals of NaCl by their kinetic energy.
 - Water molecules attract Na⁺ and Cl⁻ ions by directing the suitable pole towards each of them to be separated from NaCl crystal.
 - Water molecules which surround the ions isolate positive ions from negative ions and prevent their binding again, where the ions become hydrated and then they disperse regularly to form a solution.

The speed of the dissolving process depends on :

- Surface area of the solute.
- The stirring process.

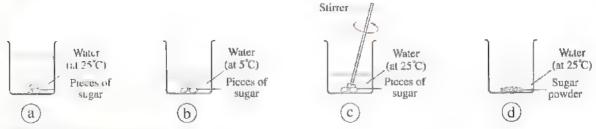
• Temperature.

Solution Solution Table salt (NaCl) Solvent H₂O molecules surround Nu*, Cl* robs

Worked Example

In the experiment illustrated by the following figures, 2 g of sugar are used with different volumes of water at different temperatures.

What is the state in which the dissolution process of solute in the solvent takes longer time?



Idea of answering:

- Dissolving process increases (the time of dissolution decreases) by the increase of each of the following:
 - Surface area of the solute, hence the choice d is excluded.
 - Stirring process, hence the choice © is excluded.
 - Temperature, hence the choice (a) is excluded.

Answer: The correct choice is (b)

Solublity

- * The ability of the solute to be dissolved in a certain solvent, or the ability of the solvent to dissolve a certain solute can be determined by the indication of what is known as solubility.
- Solubility is the mass of the solute in grams, which dissolves in 100 g of the solvent to form a saturated solution at standard temperature and pressure (STP), and it is estimated in (g solute/100 g of water).

Factors affecting the exclubility

- The nature of solvent and solute.
- The temperature.



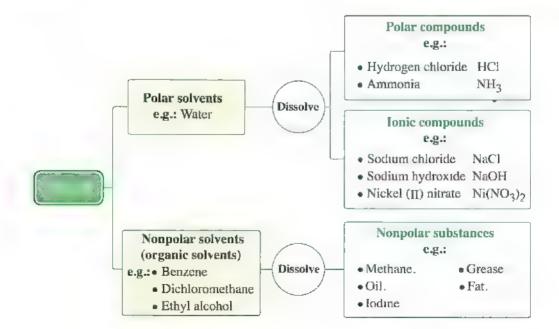
The nature of solvent and solute

"Likes dissolve likes" is a well known statement which controls the solubility process, this statement can be explained as follows:





- * Most of the covalent compounds dissolve in organic solvents.
- HCl is a covalent compound which dissolves in polar solvents as well as organic solvents.

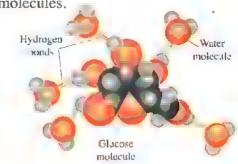




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Solubility of some substances in polar and nonpolar solvents.

- Oil is insoluble in water, because water is a polar solvent and oil is a nonpolar substance, so oil doesn't dissolve in water.
- Oil is soluble in benzene,
 because oil (nonpolar substance) is dispersed between molecules of benzene (nonpolar solvent), due to the weak bonds between the benzene molecules.
- Sugar is soluble in water, although sugar is a nonpolar substance, because water molecules form hydrogen bonds with sugar molecules, because they contain polar hydroxyl groups (OH⁻) as shown in the figure.



Dissolving of glucose in water due to formation of hydrogen bonds

O The opposite figure shows a tube containing a heterogeneous mixture of water and dichloromethane.

a heterogeneous mixture of water and dichloromethane.

It is observed that: dichloromethane does not dissolve in water, because water is a polar solvent, while dichloromethane is a nonpolar substance, where the nonpolar substances don't dissolve in polar solvents.

Water

D.chloromethane

By adding

Iodine to this heterogeneous mixture



It dissolves in dichloromethane, but not in water, because iodine is a nonpolar substance and dichloromethane also is a nonpolar solvent, but water is a polar solvent, where the nonpolar substances don't dissolve in the polar solvents, but dissolve in the nonpolar solvents.

The green nickel (II) nitrate to this heterogeneous mixture



It dissolves in water but not in dichloromethane, because nickel (II) nitrate is an ionic substance and water is a polar solvent, while dichloromethane is a nonpolar solvent, where the ionic substances dissolve in the polar solvents, but don't dissolve in the nonpolar solvents.

Test Yourself

A wall is painted with an old paint, a part of it is mistakenly sprayed with a new paint, so if the two paints can not dissolve in the same solvent.

Which of the following solvents can remove the new paint without damaging the old paint?

Solvent	Old paint	New paint	
(a)	Does not dissolve in it	Does not dissolve in it	
Ь	Does not dissolve in it	Dissolves in it	
©	Dissolves in it	Does not dissolve in it	
<u>d</u>	Dissolves in it	Dissolves in it	

Answer: The correct choice is ...

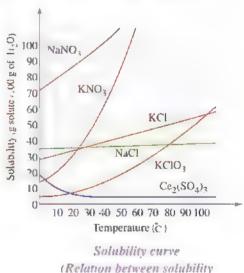


Effect of temperature on solubility

The Following diagram shows the solubility of several salts at different temperatures.

There are three cases:

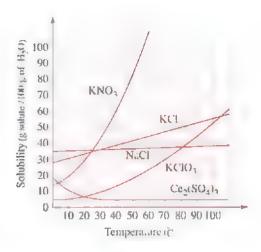
- The solubility of most salts increases greatly by increasing the temperature, such as NaNO₃, KNO₃, KCl and KClO₃
- The solubility of some salts increases slightly by increasing the temperature, such as NaCl
- The solubility of some salts decreases by increasing the temperature, such as Ce2(SO4)3



(Relation between solubility and temperature)

West last incurrence

- 1 Study the diagram, then answer the following questions:
 - (1) What is the substance whose solubility increases with decreasing the temperature ?
 - (2) What is the difference in the mass of potassium nitrate which is dissolved in a saturated solution of it, when heated from 20°C to 40°C?



- (3) Calculate the mass of KCI required to be dissolved in 200 g of water to form a saturated solution at 80°C
- (4) Calculate the mass of the precipitated KClO₃ after cooling a saturated solution of it, from 70°C to 30°C

Answer:

- (1) $Ce_2(SO_4)_3$, its solubility increases with decreasing temperature.
- (2) The difference in the mass of potassium nitrate = 60 30 = 30 g
- (3) It is clear in the solubility curve that at 80°C, 50 g of KCl dissolve in 100 g of water to form a saturated solution.

- \therefore Mass of dissolved KCl in 200 g of $H_2O = \frac{50 \times 200}{100} \mp 100$ g
- (4) Mass of the precipitated $KClO_3 = 30 10 = 20 g$

The opposite table shows the masses of the solutes and those of the solvents in 4 different solutions at 60°C In which of these solutions the mass of the solute in its saturated solution (at 60°C) is the largest?

Solution	Solute mass	Solvent mass
(W)	10 g	50 g
(X)	20 g	60 g
(Y)	30 g	120 g
(Z)	40 g	80 g

/	
(0)	/XX/\
(a)	1 VV I
	1

Idea of answering:

* Compare the mass of the solute in each solution relative to a constant mass of the solvent (let it be 120 g of the solvent in each solution).

Solution (W)	Solution (X)	Solution (Y)	Solution (Z)
10 g 50 g x g 120 g	xg 120 g	30 g 120 g	40 g 80 g x g 120 g
$\therefore x = \frac{10 \times 120}{50}$ $= 24 \text{ g}$	$\therefore x = \frac{20 \times 120}{60}$ $= 40 \text{ g}$	$\therefore x = 30 \text{ g}$	$\therefore x = \frac{40 \times 120}{80}$ $= 60 \text{ g}$

.. The mass of the solute in the solution (Z) at 60°C is the largest.

Answer: The correct choice is (d)

Questions







ourself

3.00 33000	Answer them yo
Choose the correct answer:	
(1) Mixture of cobalt (II) chloride in water	is
a. heterogeneous.	b. a solution.
c. a suspension.	d. a colloid.
(2) What is the mixture whose components	can be distinguished by the naked eye?
a. Sodium chloride in water mixture.	b. Oil in water mixture.
c. Blood.	d. Hair gel.
(3) Blood and milk are examples of	
a. liquid solutions.	b. solid solutions.
c. colloids.	d. suspensions.
(4) Ethylene glycol in water is a	
a. liquid in liquid solution.	b. solid in liquid solution.
c. gas in liquid solution.	d. liquid in gas solution.
(5) The angle between the two polar bonds	in water molecule is
a. 140.5°	b. 90°
c. 105.4°	d. 104.5°
(6) One of the strongest electrolytes is	
а. H ₂ O _(l)	b. benzene.
c. HCl _(g)	d. HCl _(aq)
(7) On dissolving hydrogen chloride gas in	water, the positive hydrogen ion H*

a. separates and stay as it is.

d. does not even separate.

c. separates and evolves as a gas.

b. separates to combine with water molecule.



- (8) The saturated solution can be converted to supersaturated solution by
 - a. heating and crystallization.
 - b. heating and adding an excess amount of solute.
 - c. cooling and crystallization.
 - d. heating and filtration.
- (9) All the following substances dissolve in water, except.
 - a. sodium hydroxide.

b. iodine.

c. nickel (II) nitrate.

d. table salt.

- (10) Sugar dissolves in water, due to the formation of
 - a. covalent bonds.

b. ionic bonds.

c. metallic bonds.

d. hydrogen bonds.

Give reasons for:

- (1) The mixture of table salt in water is a solution, while the mixture of table salt in kerosene is a suspension.
- (2) Water is a polar solvent.
- (3) Hydrochloric acid is a strong electrolyte.
- (4) In aqueous solutions H⁺ ions are not found in their single form.
- (5) Sugar dissolves in water, although it is a nonpolar compound.



Open book questions

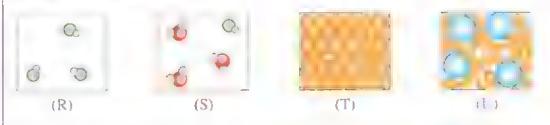
Answered





Mixtures and solutions

- Which of the following is a mixture?
 - a NaCl(l)
 - (b) NaCl_(aq)
 - (c) H₂O_(v)
 - \bigcirc H₂O_(s)
- The following four figures represent the arrangements of the particles which form four different substances:



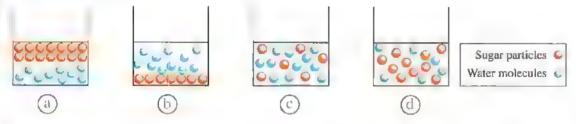
Which of the following choices represents these substances correctly?

Choices	(R)	(S)	(T)	(U)
a	Compound	Compound	Element	Compound
b	Element	Compound	Compound	Mixture
0	Element	Mixture	Compound	Compound
(1)	Compound	Mixture	Element	Mixture

- What is the type of the mixture which is composed of water, silt and table salt?
 - (a) Homogeneous mixture.
 - (b) Heterogeneous mixture.
 - © Solution.
 - (d) Blend.



Which of the following diagrams expresses the solution produced from dissolving sugar in water?



The opposite table shows the percentages of some of atmospheric air components.

Gases	Nitrogen	Oxygen	Carbon dioxide
Percentages	78%	21%	0.03%

Which of the following choices represents each of the solvent and the solute?

Choices	Solvent	Solute
a	O_2 , N_2	CO ₂
Ь	O ₂	CO_2 , N_2
(C)	N_2	CO_2 , O_2
(1)	CO ₂	O_2, N_2

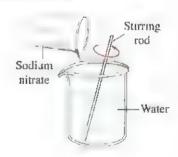
Types of solutions

The following chart shows some of the properties of the mixtures:



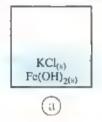
Which of the numbers shown in the previous chart represents the properties of the formed mixture which is illustrated in the opposite figure?

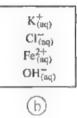
- (a) (1) and (2).
- (b) (1) and (3).
- (c) (4) and (5).
- (d) (4) and (6).

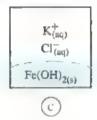


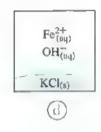
- What is the physical state of the solvent in amalgams?
 - (a) Gas only.

- (b) Liquid only.
- © Solid only.
- (d) Gas, liquid or solid.
- Which of these solutions is a good electric conductor?
 - (a) Solution of magnesium chloride in water.
 - (b) Solution of glucose in water.
 - (c) Solution of table sugar in ethyl alcohol.
 - (d) Solution of iodine in ethyl alcohol.
- Which of the following figures represents the heterogeneous mixture which is produced from mixing KOH solution and FeCI2 solution?









Dissolving process

- A crystal of potassium chloride is formed of
 - (a) KCl molecules.
- (b) Cl and K atoms.
- (c) Cl⁺ and K⁻ ions.
- (d) Cl and K ions.
- The opposite table shows the solubility of three substances (X), (Y) and (Z) in different solvents.

What is the type of each of the substances (X), (Y) and (Z)?

Substance	Solubility
(X)	Dissolves in water but not in alcohol
(Y)	Dissolves in alcohol but not in water
(Z)	Dissolves in both water and alcohol

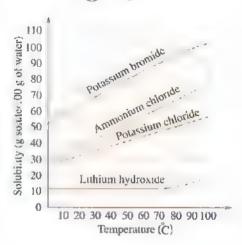
Choices	(X)	(Y)	(Z)
a	Ionic	Polar	Polar
Ъ	Nonpolar	Ionic	Nonpolar
0	Ionic	Nonpolar	Polar
(1)	Polar	Nonpolar	Ionic



- 🔯 📒 On adding a strip of magnesium to a beaker containing a solution of hydrogen chloride dissolved in dichloromethane, it was noticed that no reaction takes place. What is the action which can be taken to start a reaction between these contents in the beaker that yields hydrogen gas?
 - (1) Heating the contents of the beaker.
- (b) Adding water to the beaker.
- (c) Sturing the contents of the beaker well. (a) Adding more dichloromethane.
- \bigcirc If the solubility of a salt in water equals (20 g/100 g of H_5O) at a certain temperature. What is the mass of the salt required to be added to 300 g of water to obtain a saturated solution at the same temperature?
 - (a) 20 g
- (h) 40 g
- (c) 60 g
- d) 80 g

The opposite graph represents the solubility curve of some substances in water, and the table shows their solubilities at 40°C:

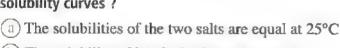
Solution	Solute	Mass of solute/100 g of H ₂ O (at 40°C)
(A)	КВг	75.4 g
(B)	NH ₄ Cl	48.8 g
(C)	KCl	32 g
(D)	LiOH	13 g



Which of these solutions shown in the table is unsaturated?

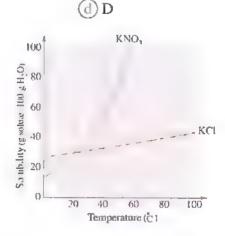
(a)A

- 📧 🌉 The opposite graph represents the solubility curves of both potassium nitrate KNO3 and potassium chloride KCl in water. Which of the following explains these two solubility curves?



- (b) The solubility of KNO₃ is always higher than
- that of KCl (c) The solubility of KCl increases significantly by
- (d) The solubility of KNO₃ is the highest at 56°C

increasing the temperature.





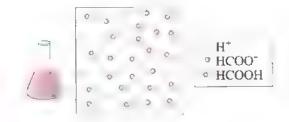
Types of solutions

- Determine the solvent in the homogeneous mixture which is composed of 20 mL of ethanol with 100 mL of propanol. Explain.
- Classify the components of the following solutions by filling in the spaces in the next table:

Solution	Type of solution	Solute state	Solvent state
(1) Atmospheric air	Gas	Gas	****
(2) Sea water	40>>000,000	*** *********	• • • • • • • • • • • • • • • • • • •
(3) Bronze alloy	Solid	1 2 2 4 2 2 4 4 7 4 4 4 4 4 4	*********

- 18 There are two samples (A) and (B):
 - Sample (A) contains a salt solution, prepared by dissolving table salt in water.
 - Sample (B) contains a solid salt, its chemical formula is NaCI
 - (1) Classify the components of each sample whether, (Element / Compound / Mixture).
 - (2) Mention two differences between the samples (A) and (B) in the light of your former classification in the part (1).
- The opposite figure represents a homogeneous mixture of formic acid HCOOH with water. Is this mixture a good electric conductor or a weak electric conductor? Explain.

"Note: Water H₂O molecules are neglected in the figure for simplification".



The two following figures represent the electric conductivity of two equal volumes of pure water, I g of sodium sulphate salt is added to one of them and 1 g of table sugar is added to the other (in no particular order).

Indicate the type of the solution in each figure.

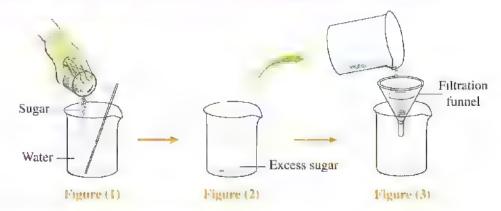


Figure (A)

I grace by



21 Study the illustrated processes in the following figures, then answer:



- (1) What is the type of the formed solution in the beaker illustrated in figure (3)? Explain.
- (2) What is expected to happen when the solution in the beaker illustrated in figure (2) is heated? What is the type of the formed solution?
- 22 How can you differentiate between a saturated solution and a supersaturated solution of the same substance (at 40°C) with two different methods?

Dissolving process

- 23 30 g of sodium bromide are dissolved in 100 g of water at temperature 20°C. so an aqueous solution of sodium bromide is formed, this trial is repeated in 100 g of kerosene:
 - (1) Can the particles of sodium bromide in the aqueous solution be distinguished by naked eye ? Explain.
 - (2) What is the difference between the type of the mixture of sodium bromide with water and its mixture with kerosene?
- The opposite figures illustrate two different mixtures. of a polar substance and an organic substance:
 - (1) Which of the opposite figures represents a mixture of water and ethanol? Explain.
 - (2) Blue copper (II) sulphate salt is added to the heterogeneous mixture, so the lower part becomes blue unlike the upper part as shown in figure (1), explain the reason for that.

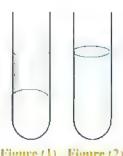
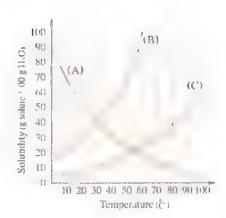


Figure (1) Figure (2)

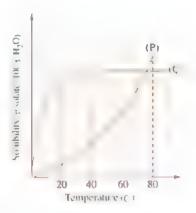
- The opposite figure represents the change in the solubility of three substances (A), (B) and (C) as a result of the change in the temperature :
 - (1) Which of these substances its solubility increases significantly with increasing temperature?
 - (2) At which temperature does the solubility of the substance (A) become the highest?
 - (3) What is the mass of the substance (C) which is required to form a saturated solution when it dissolves in 100 g of H₂O at 70°C?



The opposite graph represents

the solubility curves of two salts (P) and (Q) in water:

- (1) Which of the two salts is more soluble in water at 20°C ?
- (2) Which of the two salts its solubility in water increases significantly on raising temperature above 20°C?
- (3) Mention one other factor other than temperature that can increase the solubilities of the two salts in water.



Choosing two out of five choices questions:

- Which of the following dissolves in water forming a solution that has high ability to conduct electricity?
 - a Na₂CO₃

(b) C₂H₅OH

(c) HCl

(d) NH₄OH

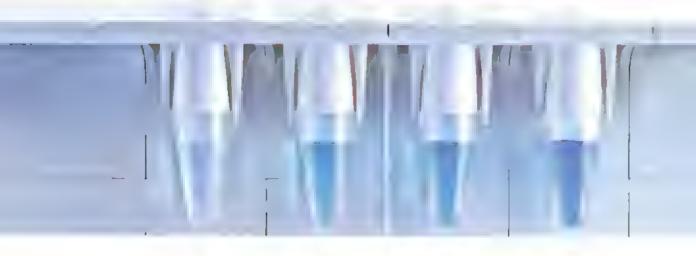
- © CH₃COOH
- The solubility of potassium nitrate salt in water is (30 g / 100 g H₂O) at 20°C All the following solutions of potassium nitrate salt are saturated at 20°C, except the two solutions produced from dissolving
 - (a) 15 g of the salt in 50 mL of water.
 - (b) 140 g of the salt in 500 mL of water.
 - (c) 35 g of the salt in 150 mL of water.
 - (d) 90 g of the salt in 300 mL of water.
 - (e) 60 g of the salt in 200 mL of water.



Lesson

Frem Concentrations of solutions

Unit Before colligative properties of solutions



Concentrations of solutions

- * The ratio of the amount of the solute to that of the solvent affects the concentration of solution.
- « Accordingly :
 - The solution in which the amount of the solute is large (yet still less than that of the solvent) is said to be a concentrated solution.
 - The solution in which the amount of the solute is very small relative to that of the solvent is said to be a dilute solution.
 - * Following, we will describe several methods for expressing the concentration, which are:
 - Percentage.
 - Molarity.
 - Molality.



the concentration of any solution decreases by increasing the amount of solvent

Percentage (%)

- * This method is suitable to express the concentrations of food and medicines.
- * The percentage of a solution is expressed by two methods, according to the nature of the solute and that of the solvent, as shown in the following:



Mass percentage (m/m)



Volume percentage (V/V)

It is the percentage of the mass of solute in 100 g of solution

it is the percentage of the volume of solute in 100 mL of solution

Mass percentage (m/m) = $\frac{\text{Solute mass (g)}}{\text{Solution mass (g)}} \times 100\%$

Volume percentage (V/V) = $\frac{\text{Solute volume (mL)}}{\text{Solution volume (mL)}} \times 100\%$

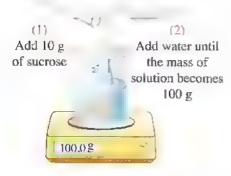
Solution mass = Solute mass + Solvent mass

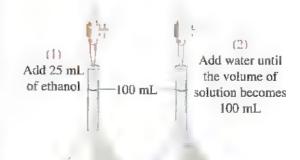
pplication

law

Preparation of an aqueous solution of sucrose 10% (m/m)

Preparation of an aqueous solution of ethanol 25% (V/V)





∴ Mass percentage = $\frac{10 \text{ g}}{100 \text{ g}} \times 100\%$ = 10%

∴ Volume percentage = $\frac{25 \text{ mL}}{100 \text{ mL}} \times 100\%$ = 25%

"with neglecting the mass of the empty beaker"

Note

The mass of 1 mL of the dilute aqueous solution equals approximately 1 g as the density of water is 1 g/mL

Worked Examples

- What is the mass percentage (m/m) of the solution produced from dissolving 10 g of sucrose in 240 g of water ?
 - (a) 2%
 - (b) 4%
 - C) 6%
 - d) 8%

Idea of answering:

Mass of the solution = Mass of the solute + Mass of the solvent

$$= 10 + 240 = 250 g$$

Mass percentage = $\frac{\text{Mass of the solute (g)}}{\text{Mass of the solution (g)}} \times 100\%$

$$= \frac{10}{250} \times 100\% = 4\%$$

Answer: The correct choice is (b)

- What is the volume percentage (V/V) of the solution produced from the addition of 25 mL of ethanol to an amount of water to form 50 mL of the solution?
 - a 25%
 - (b) 30%
 - (c) 35%
 - (d) 50%

Idea of answering:

Volume percentage = $\frac{\text{Volume of the solute (mL)}}{\text{Volume of the solution (mL)}} \times 100\%$

$$= \frac{25}{50} \times 100\% = 50\%$$

Answer: The correct choice is d



It is the number of moles of solute dissolved in one litre of solution



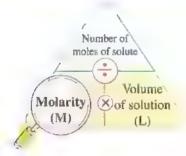
It is the number of moles of solute in one kilogram of solvent

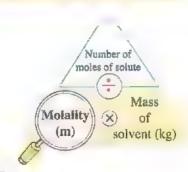
law

Molarity (M) =
$$\frac{\text{Number of moles of solute (mol)}}{\text{Volume of solution (L)}}$$

Molality (m) =
$$\frac{\text{Number of moles of solute (mol)}}{\text{Mass of solvent (kg)}}$$

Number of moles of the solute (mol) = $\frac{\text{Mass of the solute (g)}}{\text{Molar mass of the solute (g/mol)}}$





Measuring unit

The unit of molarity is (mol/L) or Molar (M) The unit of molality is (mol/kg) or molal (m)

Worked Examples

Molarity

- 1 What is the molar concentration of the solution which results from dissolving 85.5 g of table sugar $C_{12}H_{22}O_{11}$ in water to form a solution whose volume is 0.5 L?
 - (a) 0.25 M

(b) 0.5 M

[C = 12, H = 1, O = 16]

© 0.125 M

(d) $5.8 \times 10^{-3} \,\mathrm{M}$

Idea of answering:

Molar mass of $C_{12}H_{22}O_{11} = (12 \times 12) + (22 \times 1) + (11 \times 16) = 342 \text{ g/mol}$

Number of moles of the solute = $\frac{\text{Mass of the solute (g)}}{\text{Molar mass of the solute (g/mol)}} = \frac{85.5}{342} = 0.25 \text{ mol}$

Molarity = $\frac{\text{Number of moles of the solute (mol)}}{\text{Volume of the solution (L)}} = \frac{0.25}{0.5} = 0.5 \text{ mol/L} = 0.5 \text{ M}$

Answer: The correct choice is **b**

Magnesium reacts with hydrochloric acid, according to the equation:

$$Mg_{(s)} + 2HCl_{(aq)} \longrightarrow MgCl_{2(aq)} + H_{2(g)}$$

What is the volume of hydrochloric acid whose concentration is 1.5 M which is required to react completely with 17.28 g of magnesium (at STP)?

(a) 0.96 L

(b) 9600 mL

(c) 3.5 L

(d) 35.04 mL

Idea of answering:

Number of reacted HCl moles = $\frac{17.28 \times 2}{24}$ = 1.44 mol

 $\therefore Molar concentration = \frac{Number of moles (mol)}{Volume (L)}$

... Volume of HCl acid = $\frac{\text{Number of moles}}{\text{Molar concentration}} = \frac{1.44}{1.5} = 0.96 \text{ L}$

Answer: The correct choice is (a)

What are the concentrations of both the cations and the anions in 0.4 M $(NH_4)_2Cr_2O_7$ solution ?

Choices	Concentration of the cations	Concentration of the anions
(a)	0.4 M	0.4 M
(b)	0.8 M	0.4 M
©	1 M	2 M
(d)	2 M	1 M

Idea of answering:

$$(NH_4)_2Cr_2O_7$$
 \longrightarrow $2NH_4^+$ $+$ $Cr_2O_7^{2-}$
1 mol 2 mol 1 mol

 $(NH_4)^+$ cations concentration = Number of cations moles × Molar concentration = $2 \times 0.4 = 0.8 \text{ M}$

 $(Cr_2O_7)^{2-}$ anions concentration = Number of anions moles × Molar concentration = $1 \times 0.4 = 0.4$ M

Answer: The correct choice is (b)

Molality

What is the molality of a solution prepared by dissolving 20 g of sodium hydroxide

NaOH in 800 g of water?

[Na = 23, O = 16, H = 1]

(a) 0.256 m

(b) 0.425 m

(c) 0.532 m

(d) 0.625 m

Idea of answering:

Molar mass of NaOH = 23 + 16 + 1 = 40 g/mol

Number of moles of NaOH = $\frac{\text{Mass (g)}}{\text{Molar mass (g/mol)}}$ $=\frac{20}{40}=0.5$ mol

Mass of the solvent (kg) = $\frac{800}{1000}$ = 0.8 kg

Molality = $\frac{\text{Number of moles of the solute (mol)}}{\text{Mass of the solvent (kg)}}$ $=\frac{0.5}{0.8}$ = 0.625 mol/kg = 0.625 m

Answer: The correct choice is (d)

The opposite graph represents

the solubility curve of sodium nitrate salt NaNO3 illustrate by the chemical calculations the molality of a saturated solution of NaNO3 (at 40°C).

$$[Na = 23, N = 14, O = 16]$$

Answer:

Saturated solution of NaNO₂ (at 40°C) contains

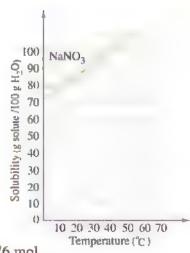
100 g of solute in 100 g of water.

Molar mass of NaNO₃ = $23 + 14 + (3 \times 16) = 85$ g/mol

Number of NaNO₃ moles in its saturated solution = $\frac{100}{85}$ = 1.176 mol

Mass of solvent in saturated solution = $\frac{100}{1000}$ = 0.1 kg

Molal concentration = $\frac{\text{Number of solute moles}}{\text{Mass of solvent (kg)}}$ $=\frac{1.176}{0.1}=11.76$ m



Test Yourself

Calculate the concentration of a solution produced from mixing 1 g of ethanol C_2H_5OH with 99 g of water H_2O , expressed by :

(1) The mass percentage.

[C₂H₅OH = 46 g/mol]

(2) Molality.

Answer:

(1) Mass of solution = $\cdots + \cdots = 100 g$

 \therefore The mass percentage = $\frac{1}{\text{Mass of the solution}} \times 100\% = \frac{1}{\text{Mass of the solution}}$

- (2) Number of ethanol moles = $\frac{\text{Mass of ethanol}}{\text{Molar mass of ethanol}} = -$
 - \therefore Mass of the solvent (kg) = $\frac{\cdot}{1000}$ = \cdots
 - $\therefore \text{ Molality} = \frac{\text{Number of moles of the solute (mol)}}{\text{Mass of the solvent (kg)}} = \frac{\dots \dots}{\dots \dots} = 0.219 \text{ m}$

Worked Example

Dilution of solutions

What is the concentration of the dilute acid produced from adding 200 mL of distilled water to 50 mL of HCl acid whose concentration is 0.2 M?

- (a) 0.01 M
- (b) 0.02 M
- © 0.03 M
- (d) 0.04 M

Idea of answering ①:

Molar concentration = $\frac{\text{Number of moles (mol)}}{\text{Volume (L)}}$

Number of moles of HCl acid = $0.2 \times \frac{50}{1000} = 0.01$ mol

Volume of dilute acid = $\frac{50 + 200}{1000}$ = 0.25 L

 \therefore Concentration of dilute acid = $\frac{0.01}{0.25}$ = 0.04 M

Idea of answering ②:

Volume of more concentrated acid $(V_1) = 50 \text{ mL}$

Volume of dilute acid $(V_2) = 200 + 50 = 250 \text{ mL}$

Concentration of more concentrated acid $(M_1) = 0.2 \text{ M}$

Concentration of dilute acid $(M_2) = ? M$

$$\mathbf{M}_1\mathbf{V}_1 = \mathbf{M}_2\mathbf{V}_2$$

 \therefore Concentration of dilute acid $(M_2) = \frac{0.2 \times 50}{250} = 0.04 \text{ M}$

Answer: The correct choice is d

A pplication

- How to prepare an aqueous solution of sodium carbonate Na_2CO_3 , its volume is 200 mL and its concentration is 0.2 M: [Na = 23 , C = 12 , O = 16]
- Calculate the mass of 0.2 M of Na₂CO₃:

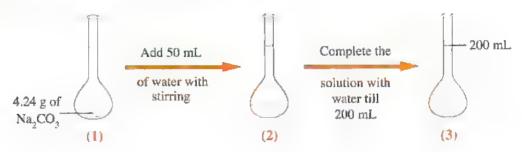
Molar mass of Na₂CO₃ = $(2 \times 23) + 12 + (3 \times 16) = 106$ g/mol

No. of Na_2CO_3 moles = Molar concentration × Volume of the solution (L)

$$=0.2 \times \frac{200}{1000} = 0.04 \text{ mol}$$

Required mass of $Na_2CO_3 = Number of moles \times Molar mass = 0.04 \times 106 = 4.24 g$

- Then follow these steps:
 - (1) Put 4.24 g of Na₂CO₃ in a flask.
 - (2) Add 50 mL of distilled water to the flask, with stirring till complete dissolution.
 - (3) Complete the solution by adding distilled water till 200 mL



Ready

Answer them yourself

200	-1			4.1			
	()	100	CO	tho	corroct	answer	-
	100	IVV	73 C	UIIC.	COLLECT	GLIDAACI	

(1) When 0.5 mol of potassium hydroxide is dissolved in an amount of water to form 250 mL of a solution, the concentration will be

a. 2 M

b. 2 m

c. 0.08 g/L

d. 0.08 mol/L.

(2) What is the volume of NaCl solution which contains 0.06 mol of the solute and its concentration = 0.3 M?

a. 0.018 L.

b. 0.2 L

c. 0.5 L

d.5L

(3) The molal concentration of a solution is expressed by

a. mol/L

b. g/eq.L

c.g/L

d. mol/kg

(4) Molal solution contains I mol of the solute in

a. 22.4 L of the solution.

b. 1000 g of the solvent.

c. I L of the solution.

d. I L of the solvent.

(5) What is the molality of the solution produced from dissolving 5.1 mol of KNO₃ in 4.47 kg of water?

a. 0.315 m

b. 1.02 m

c. 0.779 m

d. 1.14 m

Miscellaneous problems:

 Calculate the (m/m) percentage of a solution formed by dissolving 10 g of sucrose in 240 g of water.

(2) Calculate the molarity of a solution whose volume is 3 L and contains 0.5 mol of silver nitrate.

(3) Calculate the molarity of 200 mL of solution formed by dissolving 20 g of NaOH in water.

[Na = 23, O = 16, H = 1]

(4) 53 g of sodium carbonate are dissolved in 1 kg of water. What is the molality of this solution?

[Na = 23, C = 12, O = 16]



Open book questions

Answered





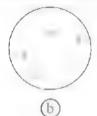
Concentrations of solutions

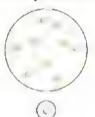
The opposite figure represents the particles in a concentrated electrolytic solution (X).

Which of the following expresses the dilute solution of the solution (X)?



"Drawing molecules of water is neglected for simplification".



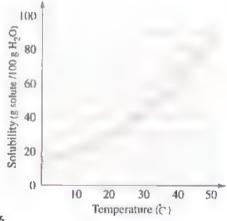




Percentage (m/m)

In the opposite graph.
What is the mass percentage concentration of the solution at 20°C?

- (a) 20%
- (b) 23.1%
- © 42.8%
- (d) 30%



What is the mass of the solution of glucose $C_6H_{12}O_6$ whose concentration is 10% and contains 1 mol of the solute?

[f = f* [f = f] O = [6]

(a) 1 kg

(b) 1.8 kg

© 200 g

d 900 g

What is the concentration of sodium hydroxide solution whose volume is 2.5 L and contains 0.4 g of NaOH?

(a) 16%

(b) 1.6%

© 0.16%

(d) 0.016%

What is the concentration percentage of an aqueous solution whose one liter contains one mole of sucrose $C_{12}H_{22}O_{11}$? |C=12,H=1,O=16|

(a) 6.84%

(b) 10%

(c) 34.2%

(d) 100%

Which of the following shows the mass of each of the solute and the solvent in potassium chloride solution its mass is 250 g and its concentration is 5%?

Choices	Mass of the solute	Mass of the solvent
(a)	12.5 g	250 g
6	25 g	225 g
0	12.5 g	237.5 g
(1)	5 g	250 g

Solution (A) is formed from mixing 300 g of solution (B) whose concentration is 25% with 400 g of solution (C) whose concentration is 40%.

What is the percentage of each of the solute and the solvent in solution (A)?

Choices	Percentage of solute	Percentage of solvent
a	23%	77%
Ь	12.5%	87.5%
0	33.6%	
(d)	50%	50%

Percentage (V/V)

The volume percentage of oxygen in atmospheric air is 21% What is the number of moles of oxygen in 1 L of air (at STP)?

a 0.186 mol

(b) 0.0094 mol

© 0.21 mol

(d) 2.1 mol



Molarity

58.5 g of sodium chloride are dissolved in an amount of water to form 0.5 L of a solution.

What is the concentration of this solution?

 $[N_0 = 23], (4 = 35.5]$

(a) 0.25 M

(b) 0.5 M

© 1 M

(d) 2 M

i	Which of the following solutions contains the highest number of moles of the solute?					
	a 10 mL of 0.5 mol/L NaCl solution.					
	(b) 20 mL of 0.4 mol/L NaCl s	solution.				
	© 30 mL of 0.3 mol/L NaCl s	solution.				
	d 40 mL of 0.2 mol/L NaCl s	solution.				
		₃ .5H ₂ O which is required to form 20	00 mL of an aqueous			
-	solution with concentration ($= 23.8 \times 32.0 \times 16.11 = 11$			
	(a) 3.16 g	b 4.96 g				
	© 24.8 g	d 31.6 g				
T	The mass of sodium carbonat	te which is required to prepare 500	mL of 0.5 M solution			
1	equals		[Na = 23, C = 12, O = 16]			
	(a) 10000 g	b 106 g				
	© 40 g	d 26.5 g				
T	An aqueous solution of sucros	se (its molar mass = 342 g/mol) conta	ins 123 g of the solute			
	and its molar concentration =	0.55 M				
	What is the volume of this sol	ution ?				
	(a) 66 mL	(b) 220 mL				
	© 340 mL	① 654 mL				
14	On dissolving 14 g of a substa	ance (\mathbf{X}) in an amount of water, a se	olution is formed			
	its volume = 2000 mL and its	s concentration = 0.25 mol/L				
	What is the molar mass of the	e substance (X) ?				
	a 14 g/mol	(b) 28 g/mol				
	© 56 g/mol	d 70 g/mol				
T	What is the concentration of the chloride ions in 1 L of a solution in which 2.08 g					
	of BaCl ₂ salt are dissolved?		[Ba = 137, C] = 35.5			
	(a) 0.01 M	b 0.012 M				
	© 0.02 M	① 2.08 M				
1	200 mL of a solution contain	0.04 mol of (NH ₄) ₂ Ni(SO ₄) ₂ .6H ₂ O				
	What is the concentration of	ammonium ions NH_4^+ in it ?				
	(a) 0.0004 M	(b) 0.008 M				
	© 0.2 M	(d) 0.4 M				

17	which of the following st	tatements represents	1	77
1	the relation between the two	o solutions		/ \
	in the opposite figure ?		150 mL	/ /
	Number of OH ⁻ moles in so			50 mL.
	(a) half its number in solution			
	(b) equal to its number in solu		Ba(OH) _{2(aq)} 0.1 M	NaOH _{(aq} 0.2 M
	double its number in solut		Solution (A)	Solution (
	(d) triple its number in solution	on (B).		
18	The concentration percentag	e of a molar solution	of sulphuric acid H	I ₂ SO ₄
	equals			[H = 1, S = 32, O = 1]
	(1) 0.098%	b 0.98%		
	© 9.8%	J 98%		
	Molarity of solutions in cher	nical reactions		
19	What is the mass of magnesi	um oxide which is req	uired to react com	pletely with
	40 mL of hydrochloric acid v	whose concentration is	s 1 mol/L ?	M) 24 0
	(1) 0.8 g	(b) 1.6 g		
	© 2.4 g	d 3.2 g		
20	According to the reaction : N	$Na_2SO_{4(aq)} + BaCl_{2(aq)}$) 2NaCl _(aq)	$+\mathrm{BaSO}_{4(\mathrm{s})}$
	What is the molarity of Na ₂ S	SO_4 solution when 250	D mL of it are requ	uired to
	precipitate 5.28 g of barium	sulphate?	[B S	52 O 16 Nr.
	a 0.09 M	ⓑ 0.9 M		
	© 0.0227 M	d 0.227 M		
21	According to the reaction : 4	$\text{FeCl}_{2(aq)} + 3O_{2(g)}$	→ 2Fe ₂ O _{3(s)} + 4Cl	2(g)
	What is the volume of 0.76 I	M solution of FeCl ₂ w		
	6.36×10^{21} molecules of oxy	ygen ?		
	(a) $5.26 \times 10^3 \text{ mL}$	ⓑ 10.7 mL		
	© 10.4 mL	d 18.5 mL		
22	On mixing 4 mL of 0.5 m	ol/L copper (II) sulph	ate solution with	4 mL of
T	0.5 mol/L sodium hydroxide			
	the reaction are			
	(a) Cu(OH) _{2(aq)} and NaOH _{(a}	q)		

b $\text{Cu(OH)}_{2(s)}$, $\text{Na}_2\text{SO}_{4(aq)}$ and $\text{CuSO}_{4(aq)}$

 $\bigodot {\rm Cu(OH)_{2(aq)}}$, ${\rm Na_2SO_{4(aq)}}$ and ${\rm CuSO_{4(aq)}}$

d $\text{Cu(OH)}_{2(s)}$ and $\text{NaOH}_{(aq)}$

What is the concentration of sulphuric acid which 25 mL of it react completely with 36.2 mL of 0.225 M sodium hydroxide solution?

(a)
$$\frac{36.2 \times 0.225}{25}$$
 M

(b)
$$\frac{2 \times 36.2 \times 0.225}{25}$$
 M

©
$$\frac{36.2 \times 0.225}{2 \times 25}$$
 M

$$\bigcirc \frac{25}{2 \times 36.2 \times 0.225} \text{ M}$$

Molality

What is the molal concentration of the solution which results from dissolving 6.44 g of naphthalene ($C_{10}H_8$) in 80 g of benzene ?

(a) 0.629 m

(b) 0.8 m

(c) 1.13 m

(d) 80.4 m

An aqueous solution of sodium chloride (its molar mass = 58.5 g/mol), its molal concentration = 3.14 m, and the mass of water in it = 2314 g

What is the mass of NaCl in this solution?

(a) 124.3 g

(b) 255.6 g

(c) 425 g

(d) 726.6 g

What is the volume of water which is required to be added to 328 g of NaOH to form a solution whose concentration is 1.35 m? $|N_0| = 23 \quad O = 16 \quad H = 11$

(a) 6.07 L

(b) 7.44 L

© 11.1 L

(d) 14.5 L

On dissolving 20 g of a salt in an amount of water, a solution is formed its mass = 280 g and its concentration is 0.2 m

What is the mass of 1 mol of this salt?

(a) 260 g/mol

- (b) 283 g/mol
- © 342.8 g/mol
- (d) 384.6 g/mol

28 If the solubility of sodium chloride salt in water = 36 g/100 g H_2O (at 20°C)

What is the molality of the saturated solution which is formed at the same temperature?

(a) 6.15 m

[Na = 23, Ci = 35.5]

- (b) 5.8 m
- © 6.15×10^{-3} m
- (d) 5.8×10^{-3} m

Dilution of solutions

29	What is the concentration of	the solution	which is	produced f	rom mixing	75 mL
Ī	of 0.05 M HCl solution with	25 mL of 3	M HCl s	olution ?		

(a) 0.375 M

(b) 0.393 M

© 0.75 M

① 0.7875 M

5 mol/L sulphuric acid has been diluted from 1 L to 10 L

What is the molar concentration of the dilute acid?

(a) 0.1 M

(b) 0.5 M

(c) 1 M

(d) 5 M

(ii) What is the volume of water which is required to be added to 500 mL of a molar solution of table salt to form 0.1 M solution of it?

(a) 100 mL

(b) 1000 mL

© 4.5 L

(d) 5 L

10 mL of 6 M hydrochloric acid were diluted with water until the concentration became 0.5 M

What is the volume of the added water?

(a) 50 mL

(b) 110 mL

© 120 mL

(d) 290 mL

Essay questions



The percentage

Calculate the percentage (m/m) of the solution which results from adding 0.5 mol of caustic soda NaOH to a given volume of water until the solution mass becomes 80 g

 $_{1}$ Na = 23 , O = 16 , H = 1]

- Calculate the mass of silver nitrate solution whose mass percentage is 15.5% and contains 25.2 g of silver nitrate.
- Calculate the percentage (V/V) of the solution which is formed by dissolving 15 mL of oil in an amount of gasoline to yield 50 mL of the solution.



Molarity

36 Sulphuric acid ionizes in water according to the following equation:

$$H_2SO_{4(aq)} \longrightarrow 2H_{(aq)}^+ + SO_{4(aq)}^{2-}$$

Calculate the concentration of each of $H_{(aq)}^+$, $SO_{4(aq)}^{2-}$ ions in 0.3 M solution.

Calculate the volume of 0.14 M sodium chloride solution which contains 1 mg of NaCl

$$[Na = 23, C1 = 35.5]$$

Molarity of solutions in chemical reactions

- 20 ml. of 0.25 VI lead (11) nitrate solution are added to an excess of potassium iodide solution whose concentration = 0.5 Ml, thus a yellow precipitate of lead (11) iodide is formed:

 [Pb = 207, 1 = 126.9]
 - (1) Write the ionic equation which represents this reaction.
 - (2) Calculate the mass of the formed yellow precipitate.
- on the reaction of magnesium with dilute hydrochloric acid, hydrogen gas evolves:
 - Calculate the volume of 1.5 M hydrochloric acid which is required to react completely with 20 g of magnesium.
 - (2) Calculate the volume of hydrogen gas produced (at STP).

Molality

- Calculate the mass of glucose $C_6H_{12}O_6$ which is required to be dissolved in 563 g of ethanol C_2H_5OH to form a solution with concentration 2.4×10^{-2} m. $\frac{10^{-12} \cdot 11^{-1} \cdot 0^{-161}}{10^{-161}}$
- Calculate the molal concentration of a solution prepared by dissolving 5.6 g of KOH in 500 mL of water. |K = 39, O = 16, H = 1|

Dilution of solutions

200 mL of water are added to 50 mL of 0.2 M HCl acid.

Calculate the molar concentration of the produced dilute solution.



- Which of the following is a solution its volume percentage (V/V) is 25%?
 - (a)A
 - (b) B
 - @ C
 - (d) D
 - (e) E

Solution	Volume of solute (m1)	Volume of solvent (m1)
A	20	100
В	15	65
С	25	75
D	30	90
E	6	14

- Which of these solutions contains the same number of moles of sodium hydroxide?
 - (a) 1 mL of 0.1 M solution.
 - (b) 10 mL of 0.1 M solution.
 - © 100 mL of 1 M solution.
 - (d) 1000 mL of 1 M solution.
 - (e) 1000 mL of 0.1 M solution.

(a) 10 g

- (b) 40 g
- (c) 0.25 mol
- d) 1.505×10^{23} molecules.
- (e) 6.02×10^{23} molecules.



Colligative properties of solutions

The properties of solutions differ from the properties of the pure solvents forming them after dissolving nonvolatile substances in these solvents at the same conditions, these new properties are called colligative (collective) properties of solutions which depend only on the number of solute particles per unit volume of solution.

Among these properties are:

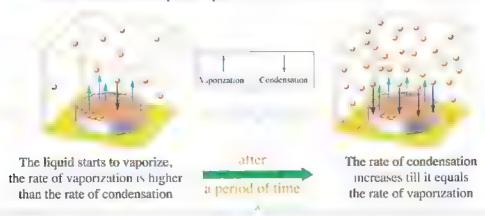
Vapor pressure depression.

Boiling point elevation.

Freezing point depression.



When an amount of a pure liquid like water is left in a closed vessel, so:



• The system (water - water vapour) in which (vaporization rate - condensation rate) is described to be at a state of dynamic pump, the vapour causes a pressure on the surface of the liquid known as vapor pressure which is the pressure that affects the liquid surface, when the vapor is at dynamic equilibrium with its liquid inside a closed container at constant temperature and pressure (at the standard conditions).

For illustration



Vapour pressure of the pure liquid or the solution is not affected by :

- Change in the external pressure.
- · Increasing or decreasing the amount of the liquid.

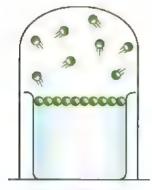
The depression of the vapor pressure of a pure solvent when a nonvolatile solute is dissolved in it to form a solution can be explained as follows:

Pure solvent

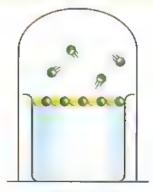
- The surface molecules which are exposed to vaporization are the solvent molecules only.
- The forces that have to be overcome are the attraction forces between the solvent molecules with each other.

Solution

- The surface molecules are the solvent and the solute molecules which are combined to each other.
- The number of sorvent molecules which are exposed to vaporization decreases.
- The forces that have to be overcome are the attraction forces between
 the solvent and the solute molecules.



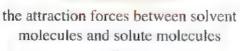
Pure solvent



Solution

and since that the attraction forces among solvent molecules

are weaker than



the vapour pressure of a pure solvent is higher than

the vapour pressure of the solution





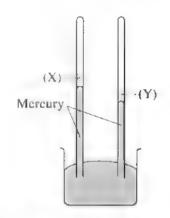




Worked Example

The opposite figure shows a container contains mercury, and two inverted tubes are placed in it, above the surface of one of them a small volume of pure water, and above the other the same volume of 10 m NaCl solution.

Which of the following represents (X) or (Y) correctly?



- (a) (X) represents water, as its vapour pressure is higher than that of the salty solution.
- (b) (X) represents the salty solution, as its vapour pressure is lower than that of water.
- (c) (Y) represents water, as its vapour pressure is lower than that of the salty solution.
- (d) (Y) represents the salty solution, as its vapour pressure is higher than that of water.

Idea of answering:

- : The length of the column of mercury under the substance (X) is longer than that under the substance (Y).
- ∴ The vapour pressure in case of the substance (X) is lower than that in case of the substance (Y).
- : The vapour pressure of the solution is lower than that of its pure solvent.
- : (X) represents the salty solution and (Y) represents water.

Answer: The correct choice is (b)

- * The depression of the vapour pressure of the solution is directly proportional to the number of moles (ions or molecules) of the solute in this solution.

 where the depression of the vapour pressure mereases (i.e. the vapour pressure decreases):
 - By increasing the number of moles of the solute molecules in it.
 - By increasing the number of moles of the solute ions in it.
- * The vapour pressure of the solution does not depend on the type of the solution.



Worked Example

Which of the following substances has the highest effect on the depression of the vapour pressure of water when 1 mol of it is dissolved in 1 kg of water?

Idea of answering:

- * The depression of the vapour pressure increases by increasing the number of moles (of ions or molecules) of the solute.
- * The correct choice is that which when ionizes, it yields the highest number of moles of ions or molecules.

(a)
$$C_2H_5OH_{(l)}$$
 water $C_2H_5OH_{(aq)}$

(b)
$$AI(NO_3)_{3(s)}$$
 water $AI_{(aq)}^{3+} + 3NO_{3(aq)}^{-}$

$$\bigcirc$$
 NaCl_(s) \longrightarrow Na⁺_(aq) + Cl⁻_(aq)

$$\begin{array}{c|c} \text{(d) } \text{CuCl}_{2(s)} & \xrightarrow{\text{water}} & \text{Cu}_{(aq)}^{2+} + 2\text{Cl}_{(aq)}^{-} \\ & \text{1 mol} & \text{3 mol of rons} \end{array}$$

... The depression in the vapour pressure of water when 1 mol of Al(NO₃)₃ dissolves in it is the greatest.

Answer: The correct choice is (b)

2 | Bailing point elevation

- * On raising the temperature of a liquid placed in a closed container, the rate of its vaporization increases, and hence its vapour pressure increases till it becomes equal to the normal atmospheric pressure, the liquid starts to boil and in this case the boiling point of the liquid is called the natural (normal) boiling point.
- * The natural (normal) boiling point is the temperature at which the vapor pressure of the liquid equals the atmospheric pressure.

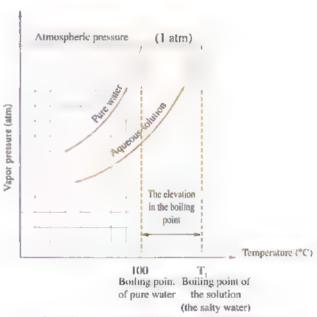
- * Measured boiling point is the temperature at which the vapor pressure of the liquid equals the pressure exerted or acted on it.
- * The boiling point can be used as an indicator for the purity of the liquids, because the measured boiling point of the pure liquid equals its normal boiling point.
- * When the pressure exerted on pure water or any other pure liquid is lower than the normal atmospheric pressure (1 atm), the measured boiling point becomes less than the normal boiling point.
- * The boiling point of solution is always higher than the boiling point of pure solvent which forms it, because the vapor pressure of solution is lower than the vapor pressure of pure solvent which forms it, the solution needs more energy until its vapor pressure equals the atmospheric pressure to boil.

· Letoning

- * The difference of the boiling point of the salty water from that of the pure water.
 - Pure water boils at 100°C
 at normal atmospheric pressure (1 atm).

 However, the addition of
 a certain quantity of salt in water
 decreases its vapour pressure, and
 consequently elevates the boiling point
 of the solution (the salty water) to T₁

 thus the boiling point of the solution is always higher than that of pure water.



The relation between the vapor pressure (atm) and both the boiling points of water and the solution (C)

Elevation of the boiling point increases:

- By increasing the number of moles of the solute molecules.
- By increasing the number of moles of the solute ions.

Worked Examples

- Which of the following solutions which have equal molar concentrations has the highest boiling point?
 - (a) HI solution.
 - (b) (NH₄)₃PO₄ solution.
 - © K2CO3 solution.
 - (d) NaI solution.

Idea of answering:

- * The boiling point of the solution increases by increasing the number of the dissolved moles in it.
- * The correct choice is the solution in which the number of the dissolved moles is the highest.

$$HI_{(f)} \xrightarrow{\text{water}} H_{(aq)}^{+} + I_{(aq)}^{-}$$

$$2 \text{ mol of ions}$$

$$(NH_4)_3 PO_{4(aq)} \xrightarrow{\text{water}} 3NH_{4(aq)}^{+} + PO_{4(aq)}^{3-}$$

$$4 \text{ mol of ions}$$

$$K_2 CO_{3(s)} \xrightarrow{\text{water}} 2K_{(aq)}^{+} + CO_{3(aq)}^{2-}$$

$$1 \text{ nol} \qquad 3 \text{ nol of ions}$$

$$NaI_{(s)} \xrightarrow{\text{water}} Na_{(aq)}^{+} + I_{(aq)}^{-}$$

$$2 \text{ mol of ions}$$

... The boiling point of (NH₄)₃PO₄ solution is the highest.

Answer: The correct choice is (b)

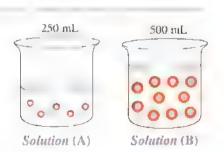
(B), each ball in them represents 0.5 mol of the solute ions, if the boiling point of solution (A) is 80°C, then the boiling point of solution (B) could be



(b) 60°C

© 80°C

(d) 100°C



Idea of answering:

Number of moles of the solute ions in solution (A) = $5 \times 0.5 = 2.5$ mol

Concentration of solution (A) = $\frac{2.5}{0.25}$ = 10 mol/L

Number of moles of the solute ions in solution (B) = $10 \times 0.5 = 5$ mol

Concentration of solution (B) = $\frac{5}{0.5}$ = 10 mol/L

- .. Both solutions are equally concentrated.
- .. They have the same boiling point.

Answer: The correct choice is (c)

Test Vourseif

Which of the following solutions that are produced from dissolving 3 g of the solute in 100 g of water has higher boiling point ?

- (a) RbF (104.5 g/mol).
- (b) HOCH₂CH(OH)CH₂OH (92 g/mol).
- © Ti(NO₃)₃ (390.4 g/mol).
- d AlCl₃ (133.5 g/mol).

Idea of answering:

* The molality of each solution, as well as the number of the moles of the ions produced in each solution are calculated as in the following table:

Choices	Molality	Ionization equation	No. of moles of the produced ions
(a)	$\frac{3 \div 104.5}{100 \div 1000} = 0.29 \text{ m}$	$RbF_{(s)} \xrightarrow{water} Rb_{(aq)}^+ + F_{(aq)}^-$	$2 \times 0.29 = 0.58$ mol ion
b	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		
<u>c</u>		-·· ·	
<u>d</u>		, , ,	

- : The boiling point of a solution ... by increasing the number of the ions dissolved in it.
- : The solution has higher boiling point than the others.

Answer: The correct choice is

3 Freezing point depression

The freezing point of solution is always less than the freezing point of pure solvent which forms it, as the attraction forces between the solvent molecules and the solute molecules in the solution hinders the conversion of the solvent from liquid state to solid state (crystals), hence it is required to decrease the temperature of the solution to less than the freezing point of the pure solvent, so that the solute crystals are separated from the solvent crystals.

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Adding salt to snow-covered roads in cold places, to prevent cars from slipping and decrease the number of accidents where salt dissolves in water forming a solution, which freezes at a temperature lower than the freezing point of pure water, so the amount of snow will decrease.



Adding salt to snow-covered roads

Freezing point depression is directly proportional to the number of dissolved solute particles in solution, where the depression of the freezing point of a solution increases:

- By increasing the number of moles of the solute molecules in it.
- By increasing the number of moles of the solute ions in it.

. I I intime

The depression of the freezing point of sodium chloride solution is double that of the freezing point of glucose solution which has the same molal concentration.

$$NaCl_{(s)} \xrightarrow{water} Na^{+}_{(aq)} + Cl_{(aq)}$$

Length 2 mol of ions

As the dissolution of 1 mol of glucose sugar in water forms 1 mol of its molecules in the solution, while dissolving 1 mol of NaCl in water forms 2 mol of ions in the solution, which leads to doubling the depression of the freezing point.



Glucose solution NaCl solut
(1 m concentration)

When I mo, of any nonelectrolyte such as glucose is dissolved in 1 kg of water, the resulting solution freezes at (-1.86°C).

while the substance which is dissociated into ions in water (electrolyte), the freezing point of its solution is calculated using the relation:

The freezing point of electrolytic solution = Number of moles of ions in the solution \times (-1.86°C)

Worked Example

Calculate the freezing point of the solution that contains 1 mol of calcium chloride CaCl₂ in 1000 g of water.

Answer:

$$CaCl_{2(s)} \xrightarrow{H_2O_{(\ell)}} Ca_{(aq)}^{2+} + 2Cl_{(aq)}^{-}$$

Limol

3 mol of ions

The freezing point of an electrolytic solution = No. of moles of ions \times (\cdot 1.86°C)

$$= 3 \times (-1.86) = -5.58$$
°C

Test Voursell

Which of the following solutions has a freezing point which equals that of an aqueous solution of $C_6H_{12}O_6$ whose concentration is 0.4 m?

(b) 0.4 m KCl

d 0.1 m Na₃PO₄

Idea of answering :

Molal concentration =

Assuming that the mass of the solvent in all solutions is 1 kg

- :. Molal concentration =
- \therefore Number of $C_6H_{12}O_6$ moles = 0.4 mol
- * The number of moles of ions of each solute is calculated.
- * The correct choice is the solute which has the same number of moles of C6H12O6

$$(a) 0.8 \times 2 = 1.6 \text{ mol}$$

(b)

(c)......

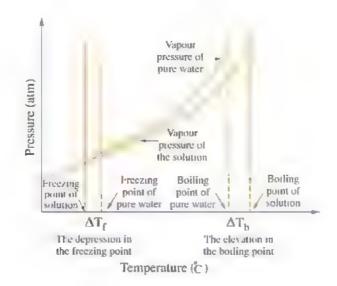
(d)

Answer: The correct choice is d

* Comparison between the solution and the pure solvent "in terms of : colligative properties"

Colligative properties	Solution	Its pure solvent
Vapour pressure	Vapour pressure of solution	< Vapour pressure of pure solvent
Boiling point	Boiling point of solution	> Boiling point of pure solvent
Freezing point	Freezing point of solution	< Freezing point of pure solvent

* The graph calling a conows the change in the vapour pressure and both boiling and freezing points of pure water when a nonvolatile substance is added to it to form a solution:





Answer them yourself

Choose the correct answer:

- (1) All the following are among the colligative properties of solutions, except
 - a elevation of the boiling point.
 - b. surface tension.
 - c. depression of the freezing point.
 - d. depression of the vapor pressure.
- (2) When the vapor pressure of pure liquid is equal to the atmospheric pressure, the measured boiling point is
 - a, higher than the natural boiling point.
 - b. equal to the natural boiling point.
 - c. lower than the natural boiling point.
- (3) Which of the following statements is correct?
 - a The boiling point of salty water is lower than that of pure water.
 - b The boiling point of salty water is equal to that of pure water.
 - c The boiling point of salty water is higher than that of pure water.
- (4) Solution (A) of glucose and solution (B) of table salt, both have the same concentration.

Which of the following represents the relation between the boiling points of these two solutions?

- a Boiling point of solution (B) \geq Boiling point of solution (A).
- b Boiling point of solution (B) > Boiling point of solution (A).
- e Boiling point of solution (B) < Boiling point of solution (A).
- d. Boiling point of solution (B) = Boiling point of solution (A)
- (5) Which of the following solutions has the highest boiling point?
 - a. I M KNO₃

b. 2 M KNO₃

c. I M Ca(NO₃)₂

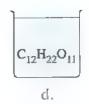
d. 2 M Ca(NO₃)₂

(6) Which of the following solutions whose molar concentration is 1 M has the lowest freezing point?









Give reasons for :

- (1) The vapor pressure of a solution is lower than the vapor pressure of its pure solvent.
- (2) The boiling point of a solution is higher than that of its pure solvent.
- (3) The boiling point of sodium carbonate solution is higher than the boiling point of sodium chloride solution with the same molal concentration.
- (4) The freezing point of a solution is lower than that of its pure solvent.
- (5) Salt is sprinkled on snow-covered roads in cold places.



Open book questions

Answered -



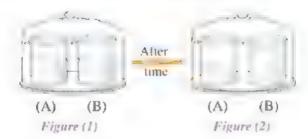


Depression of vapour pressure of the solution

- Which of the following salts has the highest effect on the depression of the vapour pressure of water when 1 mol of it is dissolved in one liter of water?
 - (a) KCl
 - (b) MgCl₂
 - (c) C6H12O6
 - (d) KBr
- Which of the following solutions all have the same molal concentration has the lowest vapour pressure?
 - (a) Acetic acid solution.
 - (b) Potassium chloride solution.
 - (c) Sodium phosphate solution.
 - (d) Sodium sulphate solution.
- An amount of oil is dissolved in a known mass of pure benzene, so if the vapour pressure of benzene is 750 mm Hg What is the vapour pressure of the solution?
 - (a) 760 mm Hg
 - (b) 750 mm Hg
 - (c) 731.5 mm Hg
 - (d) 75 mm Hg
- 4 Hydrogen gas is collected when it is prepared in lab by downward displacement of water, the pressure produced on the surface of water is the sum of the pressure of hydrogen gas and the pressure of
 - (a) oxygen gas.
 - (b) water vapour.
 - (c) hydrogen dissolved in water,
 - (d) the noble gases found in air.



Two equal volumes with different concentrations of a nonelectrolytic solution had been placed in two containers (A) and (B) as in figure (1), and after some time (at STP), these volumes were changed as in figure (2):



Which of the following represents the concentrations of both solutions as well as their vapour pressures in the case illustrated in figure (2) ?

Choices	Concentrations of the solutions	Vapour pressures of the solutions
(a)	A = B	A = B
h	A = B	A < B
0	A > B	A = B
(1)	A < B	A > B

Elevation of boiling point of the solution

fill In the opposite table.

What is the liquid whose vapour pressure is the highest at the same temperature?

- (a) Water.
- (b) Acetone.
- (c) Acetaldehyde.
- (d) Acetic acid.

Compound	Boiling point (°C)
Water	100
Acetone	56
Acetaldehyde	31
Acetic acid	118

- Which of the following aqueous solutions all have the same molal concentration has the highest boiling point ?
 - (I) CaCl_{2(aq)}
 - NaNO_{3(aq)}
 - © CH₃COOH_(aq)
 - (I) AI(NO3)3(aq)



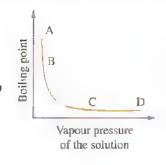
The opposite figure represents the relation

between the boiling points and the vapour pressures

of four different solutions. Which of the following compounds
forms the molal solution which is referred to by the letter (A)?



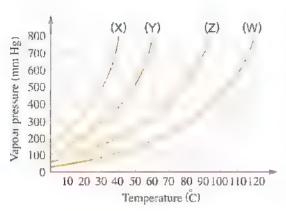
ⓑ
$$C_6H_{12}O_6$$



The graph represents the relation between the vapour pressure of 4 pure liquids (W), (X), (Y) and (Z) at different temperatures.

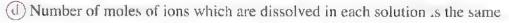
Which of these liquids has the highest boiling point?

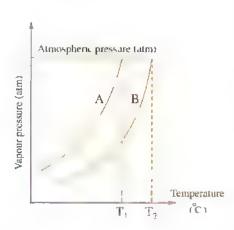




- In the opposite diagram, if T_1 is the boiling point of solution (A), and T_2 is that of (B), both solutions (A) and (B) have the same concentration.

 Which of the following statements is correct?
 - (a) Number of moles of ions dissolved in solution (B) is higher than that of the ions in solution (A).
 - (b) Number of moles of molecules which are dissolved in both solutions are equal.
 - © Number of moles of molecules dissolved in solution (A) is higher than that of the molecules in solution (B).





- Which of the following solutions of table sugar in water has the lowest boiling point?
 - (a) 2 mol/kg
 - (b) 1 mol/kg
 - © 0.5 mol/kg
 - (d) 0.1 mol/kg
- Which of the following aqueous solutions of the substance (X) which is nonvolatile has the highest boiling point ?
 - (a) A solution contains 1 mol of (X) in 2 kg of water.
 - (b) A solution contains 2 mol of (X) in 1 kg of water.
 - © A solution contains 1.5 mol of (X) in 1.5 kg of water.
 - (d) A solution contains 0.5 mol of (X) in 1 kg of water.
- When the two substances (A) and (B) are added to water, each individually, two solutions are formed which have the same boiling point.

Which of the following represents these two solutions?

Choices	Solution (A)	Solution (B)	
(a)	0.1 m sodium carbonate	0.2 m calcium nitrate	
(b)	0.1 m sodium carbonate	0.1 m calcium nitrate	
©	0.1 m potassium nitrate	0.1 m calcium nitrate	
(1)	0.1 m potassium nitrate	0.2 m calcium nitrate	

Which of the following pairs of solutions - both have the same molal concentration - the difference between their boiling points is the highest ?

Choices	Solution (X)	Solution (Y)
(1)	Glucose	Sodium chloride
(b)	Sodium chloride	Aluminum nitrate
(0)	Potassium carbonate	Potassium nitrate
0	Aluminum nitrate	Glucose

Depression of freezing point of the solution

- A solution is prepared by dissolving 1.25 mol of an unknown substance in 1000 g of pure water. Which of the following by measuring it we can conclude that the solute is an electrolyte or a nonelectrolyte?
 - (a) Temperature of water.
 - (b) Freezing point of solution.
 - © Volume of solution.
 - (d) Molar concentration of solution.
- Which of the following equally concentrated solutions has the lowest freezing point?
 - a NaCl_(aq)
 - С₆H₁₂О_{6(аq)}
 - © FeCl_{3(aq)}
 - d BaCl_{2(aq)}
- 18 Which of the following equally concentrated solutions freezes first?
 - (a) Glucose solution.
 - (b) Sodium carbonate solution.
 - © Sodium chloride solution.
 - d Potassium phosphate solution.
- Which of the following aqueous solutions whose molal concentrations are equal is preferred to be used in preventing the formation of the snow on the sidewalks in cold countries?
 - (a) $C_6H_{12}O_6$

(b) NaBr

© KNO₃

- (d) CaCl₂
- Which of the following solutions its freezing point approaches that of the aqueous solution of $C_{12}H_{22}O_{11}$ whose concentration = 0.3 m?
 - (a) 0.075 m AlCl₃
 - (b) 0.15 m CuCl₂
 - © 0.3 m NaCl
 - (d) 0.6 m C₆H₁₂O₆

1	The freezing point of ammonium sulphate solut	tion which contains 396 g of
th	e salt in 1000 g of water equals	$\{N = 14, 11 = 1, S = 32, O = 16\}$

(a)-1.86°C

(b) 2.72°C

(c)-16.74°C

- (d)-27.9°C
- Up If the freezing point of a molal solution of a salt is −9.3°C What is the probable chemical formula of this salt?
- a Na₃PO₄

(b) Al₂(SO₄)₃

© NH₄Br

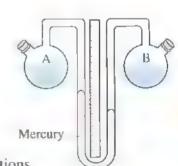
- d MgCl₂
- The colligative properties of solutions depend on the
 - a nature of the solvent.
 - (b) nature of the solute.
 - number of particles of the solvent.
 - d number of particles of the solute.
- A little amount of sodium chloride salt is added to pure water.

 What is the effect of that on the boiling and the freezing points of water?
 - Both the boiling and freezing points are elevated
 - (Freezing point is elevated and boiling point is dropped.
 - © Both the boiling and freezing points are dropped.
 - Freezing point is dropped and the boiling point is elevated.



Colligative properties of solutions

The opposite figure illustrates two flasks connected with U-shaped tube which contains an amount of mercury at room temperature and under normal pressure, one of the two flasks contains pure water and the other contains salty water, both of them have the same volume:

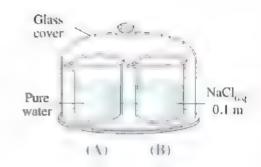


- (1) Write two factors that affect the vapour pressure of the solutions.
- (2) Which of the two flasks (A) or (B) contains pure water? Explain.
- (3) Suggest a method to make the two levels of mercury equal in its U-tube. "without removing the plugs of the two flasks".

The opposite figure represents two beakers

(A) and (B) which contain x mL of each of pure water and 0.1 m NaCl salt solution respectively.

water and 0.1 m NaCl salt solution respectively. What is the change in the volumes of the two solutions which are present in the two beakers after reaching a state of a dynamic equilibrium between water vapour and the liquids in the two beakers? Explain.

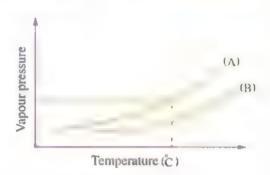


«Assuming that both the temperature and the external pressure are constant».

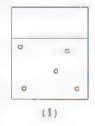
Two solutions, the volume of each of them is 1 L, the first solution contains 10 g of glucose $C_6H_{12}O_6$, while the second contains 10 g of sucrose $C_{12}H_{22}O_{11}$ Do these solutions have the same vapour pressure? Explain.

The opposite graphical figure represents the relation between the two vapour pressures of two pure liquids (A) and (B) at different temperatures.

Which of the two liquids has higher boiling point? Explain.



The following figures represent four aqueous solutions which contain the same nonvolatile solute in closed vessels at the same temperature.









(1) Determine the number of the solution which has:

1– The highest vapour pressure.

2- The lowest vapour pressure.

3-The lowest freezing point.

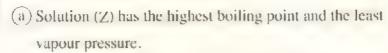
4- The highest boiling point.

(2) Determine the numbers of the two solutions which have the same vapour pressure

· Choosing two out of five choices questions:

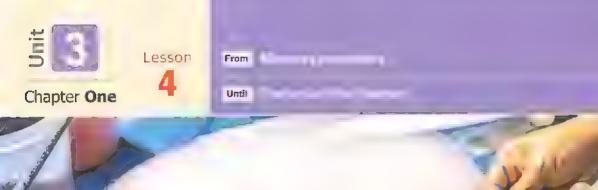
- Which of the following equally concentrated solutions (1 M) has a boiling point equal to that of 1 M aqueous solution of aluminum nitrate?
 - (a) Sodium phosphate.
 - (b) Potassium iodide.
 - (c) Calcium carbonate.
 - (d) Ammonium nitrate.
 - (e) Aluminum chloride.
- The opposite table shows the chemical formulas of 4 aqueous solutions which have the same volume and concentration.

Which of the following is correct?



	Solution	Chemical formula
	W	NaCl
1	X	C ₆ H ₁₂ O ₆
	Y	CaCl ₂
	Z	K ₃ PO ₄

- (b) Solution (W) has the least vapour pressure and the least boiling point.
- (c) Solution (Y) has the highest vapour pressure and the highest freezing point.
- (d) Solution (X) has the highest freezing point and the highest vapour pressure.
- © Solution (Z) has the highest boiling point and the highest vapour pressure.





S Propert

- * Previously, the mixtures were already classified into:
 - Solutions.

Suspensions.

- Colloids.
- * Following, the physical properties of each will be discussed.
- * Solution is a homogeneous mixture in which the diameter of its particles is smaller than 1 nm
- Properties of solution :
 - Homogeneous mixture.
 - The diameter of its particles (ions or molecules) is less than 1 nm
 - The particles of solution can't be distinguished by the naked eye or by the electronic microscope.
 - The particles forming the solution are regularly distributed. Consequently, the solution is homogeneous in its composition and properties.

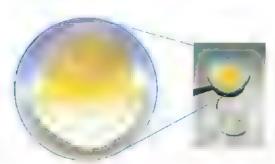


The solution doesn't scatter the light falling on it

- 1 The particles don't scatter the beam of light but allow the light to pass through it.
- * Suspension is a heterogeneous mixture in which the diameter of its particles is larger than 1000 nm and can be distinguished by the naked eye.

Properties of suspension :

- Heterogeneous mixture.
- The diameter of its particles is larger than 1000 nm
- The suspended particles can be distinguished by the naked eye.
- The suspended particles precipitate, if left for a short time without shaking.
- The suspended particles can be separated by filtration, where the filter paper can hold (trap) the suspended particles, while water (the liquid) passes through it.



Suspended particles can be separated by filtration

Examples

- Mixture of sand in water.
- Mixture of chalk powder in water.



* Colloid is a heterogeneous mixture in which the diameter of its dispersed particles ranges between 1:1000 nm and can be distinguished by the electronic microscope.

Properties of colloid:

- Heterogeneous mixture (apparently homogeneous).
- The diameter of the dispersed particles ranges between (1:1000 nm).
- The dispersed particles can be distinguished under the electronic microscope only.
- The dispersed particles don't precipitate, if left without shaking.
- The dispersed particles can't be separated by filtration.
- 1 The shape depends on its concentration:
 - Concentrated colloids appear as milk or clouds.
 - Very dilute colloids appear clear.



Tendal's phenomenon

The true solution allows the light falling on it to pass through, due to the small diameter of its particles, while the dilute colloid scatters the light because the size of the colloid particles is relatively larger, this is known as lender spacenomenon.



Acrosols are colloids take cloud shape



Solution allows a beam of light to pass through it, but dilute colloid scatters it "Tendal's phenomenon"

Note .

The colloid is an intermediate case between the solution and the suspension, because the diameters of colloid particles are in the range between (1:1000 nm), which is smaller than that of suspension (>1000 nm) and larger than that of solution (<1 nm).

Colloidal systems

- Colloidal systems consist of:
 - Dispersed phase (like in the solution). It is the substance that forms the colloidal particles.
 - Dispersion medium (like in the solution). It is the medium in which the colloidal particles are dispersed.
- * Classification of colloidal systems according to the state:

For Illustration 🥞



- " How to make natural hair gel:
 - Placing flaxseeds in a cup of water and boiling them for 5 min
 - Filtering the mixture through a piece of gauze, an odour and a colour can be added.

Dispersed phase	Dispersion medium	Examples	
Can	Liquid	Some types of whipped cream - whipped egg.	
Gas	Solid	Sweet made of sugar (cotton candy).	
	Gas	Aerosols – fog.	
Liquid	Liquid	Mayonnaise - emulsion of oil and vinegar.	
	Solid	Hair gel.	
Calid	Gas	Dust in air.	
Solid	Liquid	Pigments – blood – milk - starch in hot water.	



Pigments are colloidal systems solid (painting powder) in liquid (dispersion medium)

- When an amount of egg white is whipped by an electric hand mixer, a colloidal system (gas in liquid type) is formed.
- There is no gas in gas colloidal system, because mixed gases are homogeneous mixtures, whereas the colloid is a heterogeneous mixture.

Maritante of propering the indicate

There are two methods:

Dispersion method

 The substance is crushed into small particles until its diameter ranges between (1:1000 nm), then added to the dispersed medium with stirring.

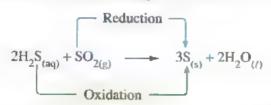
Condensation method

- The small particles are collected together into larger particles have the volume of the colloid particles, by some processes like:
 - Hydrolysis.
 - Oxidation-reduction.

Example

- When starch is stirred in water
 with heating, a colloid is formed by
 dispersion method, as the large sized
 starch particles are fragmented into
 smaller particles which disperse in water
 (dispersion medium).
- The reaction of hydrogen sulphide solution with sulphur dioxide gas, where the atoms of sulphur in water form a colloid as the atoms of sulphur aggregate together to form colloidal particles.
- Write the equation which represents -

the reaction of hydrogen sulphide solution with sulphur dioxide gas to form a colloidal system of sulphur atoms in water, illustrating the oxidation and the reduction processes.



* Comparison between solution, colloid and suspension:

Points of comparison	Solution	Colloid	Suspension
Homogeneity	Homogeneous mixture	Heterogeneous mixture	Heterogeneous mixture
Size of particles (diameter)	< 1 nm	1:1000 nm	> 1000 nm
Distinguishing the particles	Can't be seen by the naked eye or distinguished by the microscope	Can't be seen by the naked eye, but distinguished by the microscope only	Can be seen by the naked eye
Scattering light beam	Doesn't scatter the light but allows it to pass	Scatters the light	Scatters the light
Precipitation	Do not precipitate	Do not precipitate	Precipitate
Filtration (separation) of particles	Can't be separated	Can't be separated	Can be separated

Worked Example

One of the students carried out the following experiments to find out the type of the mixture formed by shaking mercury in petroleum oil.

	Experiment	Observation
(1)	On falling a beam of light on the mixture	The light is scattered
(2) 0	On leaving the mixture for some minutes after shaking	Mercury precipitates in oil
(3) Or	pouring the mixture in a funnel contains a filter paper	Mercury is separated from oil

Depending on these observations.

What is the type of this mixture?

- (a) Solution.
- (b) Colloid.
- (c) Suspension.
- (d) Blend.

Idea of answering:

- The solution allows the light falling on it to pass through, while this mixture scatters it.
- .. The mixture is not a solution.
- ... The choice (a) is excluded.
- : The colloid particles do not precipitate after shaking, and its components can not be separated by filtration.
- .. The mixture is not a colloid.
- .. The choice (b) is excluded.
- : The suspension scatters the light falling on it, its particles precipitate after shaking and its components can be separated by filtration.
- ... This mixture is a suspension.

Answer: The correct choice is (c)



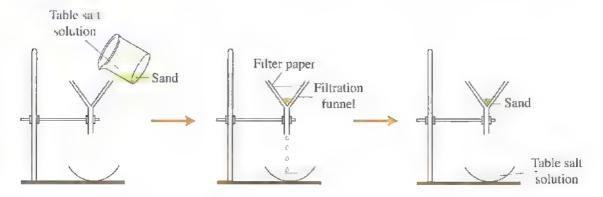
Methods of separating the mixtures

* Among the methods of separating the mixtures are :



Filtration

- * Separating the components of a mixture of solid substances, some of them are soluble, and some are insoluble by using a filtration funnel and a filter paper.
- * Example: Separating of sand from table salt in their mixture using water as a solvent.



Salty

solution



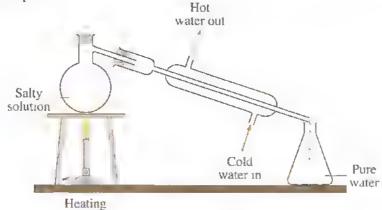
Evaporation

- * Separating a solid substance dissolved in a solution by heating.
- * Example: Separating of table salt from its solution by heating till complete evaporation of water.



Simple distillation

- * Separating the solvent from a solution by heating and condensation.
- * Example: Separating pure water from a salty solution by evaporation, then condensation of the produced vapour.



Worked Example

A filtration process was carried out for a liquid mixture using the apparatus shown in the opposite figure, after the end of the process, it was found that the mass of the dried filter paper did not change.

What do you expect the type of this mixture could be ?

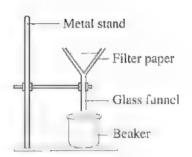
It could be either

- (a) a solution or a colloid only.
- (b) a suspension or a solution only.
- (c) a colloid or a suspension only.
- (d) a solution, a suspension or a colloid.

Idea of answering:

- The mass of the dried filter paper did not change.
- .. The filter paper did not trap the solid particles of the mixture.
- The particles of each of the solution and the colloid pass through the filter paper.
- .. This mixture could be either a solution or a colloid.

Answer: The correct choice is (a



Duestions



Answer them yourself

	15	- N	. 1	
į		hoose	the correct	DISCUSOR '
	CAL .	CHOOSE	the collect	dilanci .

disobe tite correct distrer	
(1) The particles that form the solution	
a. are invisible.	b. are visible.
c. can be separated by filtration.	d. scatter the light.
(2) In the colloid, what corresponds the solver	at in the solution is the
a. dispersed phase.	b. solute.
c. dispersion medium.	d. suspension.
(3) Cotton candy and chalk powder in water a	are
a. colloids.	b. suspensions.
c. heterogeneous mixtures.	d. solutions.
(4) Dispersion medium in the emulsion of oil	and vinegar is in the
a. solid state.	b. liquid state.
c. gaseous state.	d. vapour state.
(5) The type of the blood as a colloid is	
a. gas in gas.	b. solid in liquid.
c. gas in solid.	d. liquid in gas.
(6) Colloids can be prepared by .	
a. polymerization.	b. dispersion.
c. precipitation.	d. hydrogenation.
Give reasons for	

- (1) We can distinguish between the suspension and colloid by the naked eye.
- (2) A mixture of sugar in water is a solution, while a mixture of milk powder in water is a colloid.
- (3) The colloid can scatter the light beam falling on it.
- (4) The colloid is an intermediate case between the solution and the suspension.
- (5) There is no colloid of gas in gas type.



Open book questions

Answered







Mixtures properties

- Addition of sodium hydroxide solution to hydrochloric acid yields
 - d a mixture whose particles can be distinguished by the microscope.
 - (b) a suspension which is apparently homogeneous.
 - a solution whose particle diameter is less than 1 nm
 - (d) a homogeneous mixture whose particles can be separated by filtration.
- Table salt powder is
 - (1) a compound.
- (b) a solution.

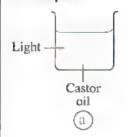
(c) a colloid.

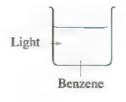
- (1) a suspension.
- A mixture of sugar in kerosene is formed of particles whose diameter may equal
 - (1) 10000 nm

(b) 980 nm

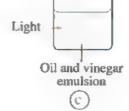
© 100 nm

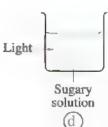
- (d) 0.1 nm
- Which of the following is not a suspension?
 - a Antibiotics which need shaking before use.
 - h Muddy rains.
 - (c) Coffee.
 - (d) Soft drinks.
- When a light beam falls on a glass beaker contains a mixture of water and silt, it is scattered, this indicates that this mixture is
 - (a) a colloidal system.
- homogeneous.
- (c) a suspension.
- (d) a solution.
- In which of the following beakers, the light is scattered when it passes through the liquid?





(b)





- The opposite figure shows a jar
 of mayonnaise (which is composed of eggs
 dispersed in oil in addition to other components).
 What is the type of mayonnaise mixture?
 - (1) Homogeneous solution.
 - h Apparently homogeneous suspension.
 - (c) Apparently homogeneous colloid.
 - d Heterogeneous suspension.
- Foam which is known commonly as industrial sponge, is a kind of a colloidal system similar to the type of
 - a hair gel.
 - (b) blood.
 - whipped egg whites.
 - d cotton candy.



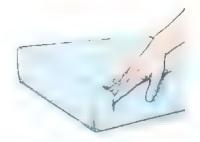
- (a) homogeneous mixtures.
- (b) solutions.
- © liquid in solid mixtures.
- d suspensions.

Mhich of the following is not a colloid?

- Milk powder in water.
- (b) Dust in air.
- © Calcium nitrate powder in water.
- (1) Paints.

- a gas is dispersed in a gas.
- (b) a gas is dispersed in a liquid.
- © a liquid is dispersed in a gas.
- (d) a gas is dispersed in a solid.





- Cheese, hair gel and gelatin are mixtures in which ...
 - (a) a liquid dissolves in a solid.
 - (b) a liquid is dispersed in a solid.
 - (c) a solid dissolves in a liquid.
 - (d) a solid is dispersed in a liquid.
- 13 On shaking a bottle of a soft drink, an effervescence takes place, and the colloid (X) is formed on removing the bottle cap. What is the type of the dispersed phase and of the dispersion medium in the colloid (X)?

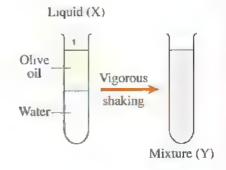
Choices	Dispersed phase	Dispersion medium
a	Gas	Liquid
b	Liquid	Solid
©	Liquid	Gas
(d)	Solid	Gas



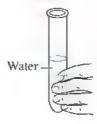
- On adding liquid (X) to a mixture of olive oil and water, mixture (Y) is formed, as in the figure. What is the type of mixture (Y)?
 - (a) Oil in water solution.
 - (b) Oil and water suspension.
 - © Oil in water emulsion.
 - (d) Oil and water amalgam.
- 15 On adding a little amount of maize starch to cold water with good stirring, a mixture is formed which cannot be separated by filtration.

Which of the following represents the type of this mixture?

Choices	Homogeneous	Solution	Suspension	Colloid
a	Х	1	Х	1
b	1	✓	х	Х
0	Х	Х	Х	1
(1)	1	Х	1	Х







Methods of separating the mixtures

the properties of these mixtures?

16 __ The opposite figure represents the filtration of a mixture formed from a solution. a suspension and a colloid. Which of the following shows the particles of each of them in the light of your understanding of

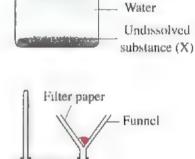
• (A) B) C)
(C)	
particles	
particles	
on particles	
.1.1	

Choices	(A)	(B)	(C)
(1)	Solution particles	Suspension particles	Colloid particles
(b)	Colloid particles	Suspension particles	Solution particles
0	Colloid particles	Solution particles	Suspension particles
	Solution particles	Colloid particles	Suspension particles

- 177 What is the suitable method to separate substance (X) from water in the mixture which is illustrated in the opposite figure?
 - (a) Simple distillation,
- (b) Vapourization.

© Filtration.

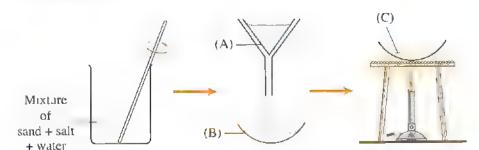
- (d) Magnetic separation.
- What is the mixture which can be separated by the method illustrated in the opposite figure?
 - (a) Copper and aqueous solution of copper (II) chloride.
 - (b) An aqueous solution of copper (II) chloride and sodium chloride.
 - (c) Water and ethyl alcohol.
 - (d) Ethylene glycol and water.
- 😰 Which of the following separation methods proves that sodium chloride acts as a solute in sea water?
 - (a) Condensation.
- (b) Fractional distillation.
- (c) Vapourization.
- (d) Filtration.
- What is the property on which the separation of sand from the table salt solution in their mixture is based?
 - (a) Concentration of the ions. (b) Volume of the sample.
- - (c) Mass of the sample.
- (d) Size of the particles.



- What are the steps followed to separate potassium nitrate salt from a mixture with calcium phosphate ?
 - (d) Dissolving Vaporization Crystallization Filtration.
 - (b) Dissolving → Filtration → Vaporization → Crystallization.
 - © Filtration → Crystallization → Vaporization → Dissolution.
 - (d) Filtration --- Vaporization --- Crystallization --- Dissolution.
- The separating funnel which is illustrated in the opposite figure is used to separate the two solutions (X) and (Y).

Which of the following represents the two liquids (X) and (Y)?

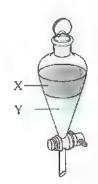
- (a) Liquid (Y) acts as a dispersion medium for the liquid (X).
- (b) The boiling point of liquid (Y) is higher than that of liquid (X).
- (c) The two liquids (X) and (Y) form a heterogeneous mixture.
- (d) The freezing point of liquid (X) is lower than that of liquid (Y).
- The following figures represent the followed steps in separating a mixture of sand and salt :



Which of the following represents (A), (B) and (C) correctly?

Choices	(A)	(B)	(C)
a	Salt	Water	Sand
6	Salt	Salt solution	Sand
0	Sand	Water	Salt
(1)	Sand	Salt solution	Salt

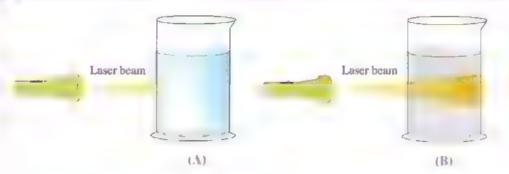






Mixtures properties

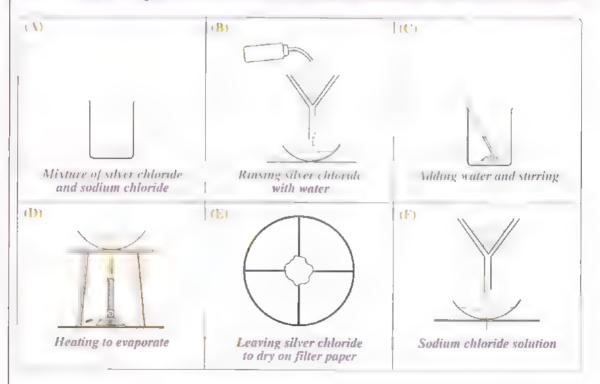
24 A laser beam is passed in two different mixtures in the beakers (A) and (B):



- (1) Which of them is a colloid? Explain.
- (2) What is the type of the mixture which is found in the other beaker? Explain.

Methods of separating the mixtures

There is a mixture of sodium chloride and silver chloride salts required to be separated, arrange the steps which are illustrated by the following figures to state the followed steps in separating this mixture to obtain sodium chloride first then silver chloride.



New types of questions?



Choosing two out of five choices questions:

- On stirring 90 g of NaCl in 100 g of water at 90°C, NaCl disappears completely.

 Which of the following is correct?
 - (a) A homogeneous compound of NaCl is formed.
 - (b) The particles of the produced mixture can be separated by filtration.
 - (c) On cooling, a saturated solution of NaCl is formed.
 - (d) The formed mixture scatters the light falling on it.
 - (e) The particles of the produced mixture cannot be distinguished by microscope.
- The opposite table shows the diameters of the particles of some mixtures.

 Which of the following is correct?
 - (a) Mixture (A) allows the falling light to pass through it.
 - (b) Mixture (B) particles can be separated by filtration.
 - (c) Mixture (D) particles do not precipitate after shaking.
 - (d) The two mixtures (A) and (D) are both heterogenous.
 - (e) The two mixtures (B) and (C) are both apparently homogenous.

Diameters of particles (nm)
0.2
300
500
1200



Uses of acids and hases

- * Acids are used in many chemical industries, like:
 - Fertilizers.
- Explosives.
- Medicines.
- Plastic.
- Car batteries.
- * Bases also have many uses in chemical industries, like:
 - Soap.
- Detergents.
- Dyes.
- Medicines.

• Vinegar is a dilute solution of acetic acid, it is one of the oldest acidic solutions that was early discovered, it is used in food, as well as in cleaning processes.



Acids and bases are used in manufacture of medicines



Detergents are bases



Lemon and tomato contain acids

* The following tables show some of the natural and industrial products and the acids and bases entering in their composition or preparation:

Product	Acids found in its composition
Citrus plants (lemon - oranges - tomatoes)	Cıtric acid – Ascorbic acid
Dairy products (cheese - yogurt)	Lactic acid
Soft drinks	Carbonic acid – Phosphoric acid

Product	Bases found in its composition
Soap	Sodium hydroxide
Baking soda	Sodium bicarbonate
Washing soda	Hydrated sodium carbonate

Properties of acids and bases

* General properties of acids and bases can be compared as follows:

Acids

- (1) Have sour taste.
- (2) Change the color of purple litmus indicator or litmus paper into red.



Acids change the color of litmus indicator into red

Alkalis (Bases)

- (1) Have bitter taste and slippery (soapy) feel.
 - (2) Change the color of purple litmus indicator or litmus paper into blue.



Bases change the color of litmus indicator into blue

(3) Alkalis (Bases) react with acids producing salt and water

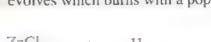
 $NaOH_{(aq)}$ + $HNO_{3(aq)}$ - $NaNO_{3(aq)}$ + $H_2O_{(f)}$ Sodium hydroxide Nitric acid Sodium nitrate Water Base Acid Salt

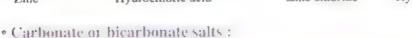
Acids react with:

Active metals :

evolves which burns with a pop and Producing sound when a lit splint is exposed to it.







Causing effervescence and producing limewater turbid.

 $CO_{2(g)}$ Na₂SO_{4(an)} Na₂CO_{3/s3} + H₂O_(A) H₂SO_{4(sig)} Water Carbon Sodium carbonate Sulphuric Sodium dioxide gas acid sulphate



CO, gas turns clear limewater turbid after passing for short time

cories defining acids and bases

- The apparent characteristic properties of acids and bases lead to for each of them.
- is based on observation only and doesn't describe or explain the invisible properties of the acids and bases which lead to the behaviour of each of them.
- The more comprehensive definitions of acid and base come from the studies and experiments, that were placed in the form of theories.

Acid-base theories:







 Arrhenius observed that the aqueous solutions of acids and bases conduct electricity, so he concluded that acids and bases ionize in water forming positive and negative ions, which is shown as follows:



Note

Covalent compounds like hydrogen chloride ionize in water, while ionic compounds as sodium hydroxide dissociate in water

Dissolution of hydrogen chloride in water

When hydrogen chloride gas dissolves in water, it ionizes into hydrogen ions (H⁺) and chloride ions (Cl)

$$HCl_{(g)} \xrightarrow{H_2O_{(t)}} H^{\dagger}_{(aq)} + Cl_{(aq)}$$

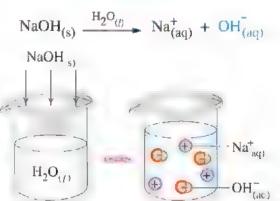
$$HCl_{(g)}$$

On dissolving $HCl_{(g)}$ in water it gives H^+ ions

'Arrhenius acid"

Dissolution of sodium hydroxide in water

When sodium hydroxide dissolves in water, it **dissociates** to sodium ions (Na⁺) and hydroxide ions (OH⁻)



On dissolving NaOH₍₈₎ in water it gives OH ions
"Arrhenius base"

Based on that, Arrhenius defined acids and bases, as follows:

Arrhenius acid

Is the substance that dissolves in water and ionizes or dissociates giving one or more hydrogen ions (H⁺)

Arrhenius base

is the substance that dissolves in water and ionizes or dissociates giving one or more hydroxide ions (OH⁻)

Arrhenius base must contain a source of

hydroxide ions (OH)

According to Arrhenius theory we observe that

Arrhenius acid must contain a source of hydrogen ions (H⁺)

Arrhenius acid acts on increasing

Arrhenius base ac

the concentration of (H⁺) ions in the aqueous solutions

$$H_2SO_{4(\frac{1}{\ell})} \xrightarrow{\text{water}} H_{(aq)}^+ + HSO_{4(aq)}^-$$

Sulphuric acid

Arrhenius base acts on increasing the concentration of (OH⁻) ions in the aqueous solutions

$$KOH_{(s)} \xrightarrow{\text{water}} K_{(aq)}^+ + OH_{(aq)}^-$$

Potassium hydroxide

Note)

Positive hydrogen ion H⁺ in aqueous solutions can be termed hydronium ion H₃O⁺

Workhall xample

Classify the following substances into Arrhenius acid or Arrhenius base, giving reasons:

Answer:

	Substance	Represents	Explanation
(1)	HNO _{3(ℓ)}	Arrhenius acid	Because it dissolves in water giving II^+ ions. $HNO_{3(l)} \xrightarrow{H_2O_{(l)}} H^+_{(aq)} + NO^{3(aq)}$
(2)	Ba(OH) _{2(s)}	Arrhenius base	Because it dissolves in water giving OH ⁻ ions. $Ba(OH)_{2(s)} \xrightarrow{H_2O_{(\ell)}} Ba_{(aq)}^{2+} + 2OH_{(aq)}$

Explaining neutralization reaction according to Arrhenius theory

Neutralization reaction is the reaction between an acid and a base to produce salt (an ionic compound) and water.

A pplication

The ionic equation of this reaction according to Arrhenius theory is:

$$H_{(aq)}^+ + CI_{(aq)}^+ + Na_{(aq)}^+ + OH_{(aq)}^- \longrightarrow Na_{(aq)}^+ + CI_{(aq)}^+ + H_2O_{(l)}$$

Na_(aa) and Cl_(aa) ions are present in both sides of the equation without changing.

So they can be cancelled from the both sides of the chemical equation.

So the neutralization reaction can be represented by the following equation:

$$H_{(aq)}^{+} + OH_{(aq)}^{-} \longrightarrow H_{2}O_{(\ell)}$$

Drawbacks of Arrhenius theory

- * Arrhenius theory cannot define all types of acids and bases, for example it cannot explain the fact that:
 - Some compounds like carbon dioxide CO₂ do not contain a source of (H⁺) ions, but they dissolve in water giving aqueous acidic solutions.
 - Some compounds like ammonia NH₃ do not contain a source of (OH⁻) ions, but they dissolve in water giving aqueous basic solutions.



Which of the following compounds is an Arrhenius acid?

(a) HBr

(b) NaOH

© NaBr

 \bigcirc NH₃

Answer: The correct choice is



The Danish scientist Brönsted and the British scientist Lowry proposed a new acid-base theory, where they could explain the acidity and the basicity of the compounds which Arrhenius failed to explain.

Brönsted-Lowry acid

It is the substance that donates the proton (H^+) .

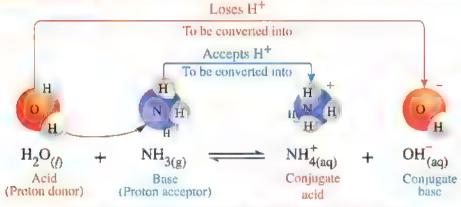
(proton donor)

Brönsted-Lowry base

It is the substance that accepts the proton (H*).

(proton acceptor)

Bronsted-Lowry theory describes the behavior of ammonia as a base.



Acid and base definitions according to Brönsted-Lowry theory

When ammonia gas dissolves in water

H₂O acts as an acid,

because it donates a proton (H⁺) to ammonia molecule (NH₃)

NH₃ acts as a base,

because it accepts the proton (H⁺) from water molecule

As a result of this transfer

OH ion is formed (remained from the acid)
and it is called

conjugate base

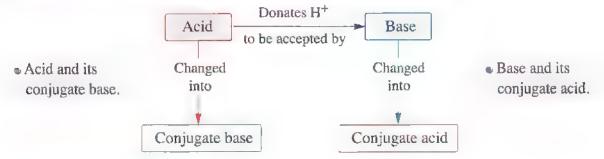
which is the substance which is formed when the acid loses a proton (H*)

NH⁺ ion is formed (after the base acquired a proton) and it is called

conjugate acid

which is the substance which is formed when the base accepts a proton (H⁺)

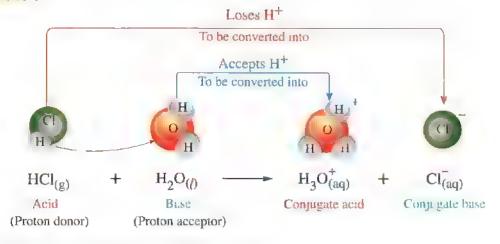
▼The following diagram shows the relation between acid and base:



Worked Examples

Write the chemical equation which represents the dissolution of hydrogen chloride gas $\mathbf{HCl}_{(\mathbf{g})}$ in water according to Brönsted-Lowry theory, then identify the acid, the base and their conjugates.

Answer:



- : HCl loses a proton to be converted into Cl
- ... The acid is hydrogen chloride gas HCl_(p) The conjugate base is chloride ion Cl_(ag)
- : H₂O accepts a proton to be converted into H₂O⁺
- ∴ The base is water H₂O_(I)

The conjugate acid is hydronium ion H₃O_(a0)

Included information

Some substances are , i.e. they act as acids (proton donors) in some reactions, and as bases (proton acceptors) in other reactions.

The following reaction proceeds in both directions:

$$HCO_3^- + H_2O \Longrightarrow H_2CO_3 + OH^-$$

What are the two acids which exist in the reaction medium according to Brönsted-Lowry theory?

(a) H₂O and OH

(b) HCO3 and OH

C H,O and H,CO3

d HCO3 and H2CO3

Idea of answering:

- : H₂O donates a proton to HCO₃ ion.
- : H2O acts as an acid in this reaction.
- .. The choices (b) and (d) are excluded.

•
$$H_2CO_3 + OH^- \longrightarrow HCO_3^- + H_2O$$

- : H₂CO₃ donates a proton to OH ion.
- ∴ H₂CO₃ acts as an acid.

Answer: The correct choice is (c)

Test Louiself

In the following reaction:

$$\mathbf{CH_{3}COOH_{(aq)} + H_{2}O_{(\ell)}} = \mathbf{CH_{3}COO_{(aq)}^{-} + H_{3}O_{(aq)}^{+}}$$

What is the pair which represents the conjugate acid and the base respectively?

(a) CH₃COOH_(ao), H₂O_(/)

(b) CH₃COO_(aq), H₃O⁺_(aq)

© H₂O_(l), CH₃COO⁻_(aq)

 $\textcircled{d} \; H_3O_{(aq)}^+ \; , H_2O_{(\ell)}$

Answer: The correct choice is

Level theory in 1927



Lewis proposed a more comprehensive acid-base theory which depends on sharing a lone pair of electrons between acid and base instead of transferring the protons.

Lewis acid

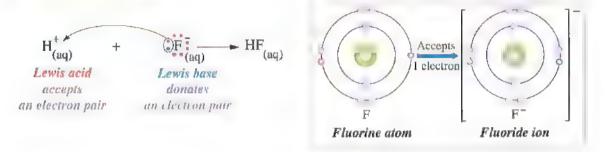
It is the substance that accepts a ione pair of electrons or more.

Lewis base

It is the substance that donates a lone pair of electrons or more.



Lewis theory explains the reaction of formation of hydrogen fluoride IIF



According to Lewis

Hydrogen ion H⁺ is the acid, as it accepts a free (lone) pair of electrons from fluoride ion F⁻

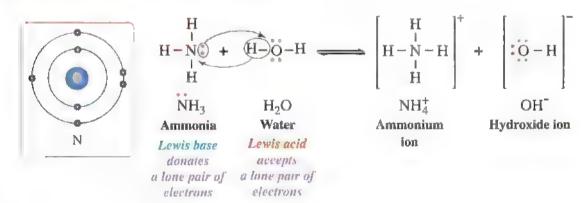
Fluoride ion F⁻ is the base, as it gives (donates) a free (lone) pair of electrons to hydrogen ion H⁺

Worked Example

Which of the following shows both the acid and the base in the dissolving process of ammonia gas NH_3 in water H_2O according to Lewis theory?

Choices	Acid	Base
(a)	Ammonia gas	Water
b	Ammonia gas	Ammonium ion
0	Water	Ammonia gas
d	Ammonium ion	Ammonia gas

Idea of answering:



: Ammonia gas donates its lone pair of electrons to water.

: Ammonia gas is the Lewis base.

... The choices (a) and (b) are excluded.

: Water accepts the lone pair of electrons from ammonia gas.

Water is the Lewis acid.

Answer: The correct choice is (c)

Note .

Ammonia is considered as a base, although it doesn't contain hydroxide ions (OH) in its composition, because according to Bronsted-Lowry theory, ammonia accepts a proton from another substance (as water) during the reaction, and according to Lewis theory it donates a lone pair of electrons to another substance (as water) during the reaction.

All the previous theories can be summarized as the following:

Theory	Acid	The substance that dissolves in water, giving one or more hydroxide ions OH NaOH _(s) water Na ⁺ _(aq) + OH _(aq)	
Arrhenius	The substance that dissolves in water, giving one or more positive hydrogen ions H ⁺ HCl _(g) water H ⁺ _(aq) + Cl ⁻ _(aq)		
Brönsted-Lowry	The substance that donates a proton H ⁺ (H)Cl _(g) + H ₂ O _(l) Acid Base	The substance that accepts a proton H ⁺ H ₃ O ⁺ _(aq) + Cl ⁻ _(aq) Conjugate Conjugate base	
Lewis	The substance that accepts a lone pair of electrons or more $H^{\dagger}_{(aq)} + F^{\dagger}_{(aq)}$ Acid Base	The substance that donates a lone pair of electrons or more $HF_{(aq)}$	



Answer them yourself

Choose the correct answer:

(1) Wha	t is	the	acid	which	is	found	in	citrus	plants	?
---------	------	-----	------	-------	----	-------	----	--------	--------	---

a. Phosphoric acid.

b. Lactic acid.

e. Ascorbic acid.

d. Carbonic acid.

(2) From the properties of acids · · · · ·

a. having a sour taste.

b. changing litmus indicator to blue.

c. having slippery feel.

d. having bitter taste.

(3) Reactions of the acids with carbonate or bicarbonate salts yield

a. hydrogen.

b. oxygen.

c. carbon dioxide.

d. sulphur dioxide.

(4) In the reaction of ammonia and hydrochloric acid, ammonium ion (NH₄) is

a. a conjugate base.

b, the base.

c. a conjugate acid.

d. the acid.

(5) The conjugate acid of HSO₄ is

a. HSO₄*

b. SO_4^2

 $c.\,H_2SO_4$

d. H⁺

(6) The substance which donates a lone pair of electrons or more is considered as

a, a Lewis acid.

b. an Arrhenius acid.

c. a Lewis base.

d. an Arrhenius base.

Give reasons for:

- (1) Hydrogen chloride gas is an Arrhenius acid when it is dissolved in water.
- (2) Arrhenius theory has drawbacks.
- (3) Ammonia gas isn't considered to be a base according to Airhenius theory, but considered to be in Bronsted-Lowry theory.



Open book questions

Answered





Uses and properties of acids and bases

- Which of the following is a property of sodium hydroxide?
 - (a) It dissolves in water yielding H+
 - b Its aqueous solution has a slippery feel.
 - © It turns the colour of litmus from purple to red.
 - 1 It reacts with magnesium and hydrogen gas evolves.
- The reaction of baking soda with sulphuric acid causes the evolution of bubbles of
 - (a) sulphur dioxide gas.

b) nitrogen dioxide gas.

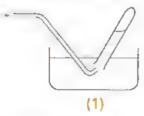
hydrogen gas.

- (d) carbon dioxide gas.
- Acids react with bases to form salt and water.

Which of the following represents the solubilities of the reactants in water?

Choices	Acid	Base
a	Soluble	Insoluble
. 0	Insoluble	Soluble
0	Soluble	Soluble
(1)	Insoluble	Insoluble

Calcium reacts with dilute hydrochloric acid forming the gas (X) which is sparingly soluble in water and lighter than air :







What is the name of this gas ? And what is (are) the proper method(s) to collect this gas when it is prepared in lab ?

- Hydrogen gas / (2) only.
- (b) Chlorine gas / (1) and (3) only.
- Hydrogen gas / (1) and (3) only.
- (1) Chlorine gas / (2) only.

Arrhenius theory

- S Arrhenius theory for defining the acid is not applied to . .
 - (a) HF in water.
- (b) HCl in water.

© HSO_{4(aq)}

- I₂ in dichloroethane.
- 6 Adding HCI acid to pure water results in
 - (a) increasing the concentrations of both H⁺ and OH⁻
 - (b) increasing the concentration of H+, and decreasing that of OH-
 - © decreasing the concentrations of both H+ and OH-
 - decreasing the concentration of H+, and increasing that of OH

Brönsted-Lowry theory

In the reaction : $H_2S_{(aq)} + CH_3NH_{2(aq)} \longrightarrow HS_{(aq)}^- + CH_3NH_{3(aq)}^+$

Which of the following represents this reaction?

- (a) H₂S is H⁺ ion donor, while CH₃NH₂ is H⁺ ion acceptor.
- (b) CH₃NH₂ is H⁺ ion donor, while H₂S is H⁺ ion acceptor.
- © Both HS⁻ and CH₃NH₃⁺ are H⁺ ion donors.
- (1) Both HS⁻ and CH₃NH₃⁺ are H⁺ ion acceptors.
- 8 In the following equation:

$$HCl_{(g)} + H_2O_{(f)} \longrightarrow H_3O^+_{(a\alpha)} + Cl^-_{(a\alpha)}$$

Which of the following statements represents what happens in this reaction?

- (4) Chloride ion is formed by gaining an electron from water.
- (b) Hydrogen chloride molecule loses an electron forming chloride ion.
- (c) Water gains a proton from hydrogen chloride.
- (d) Water donates a proton to hydrogen chloride.
- - (a) H₃O*

 \bigcirc AsO₄³

C H3AsO4

- (d) H2AsO4
- What is the conjugate base of the acid H₂BO₃?
 - (a) BO₂3-

(b) H₃BO₃

(c) HBO₂

(d) $H_3BO_2^+$

- The conjugate base of ethanol C₂H₅OH is
 - (a) CH₃CH₂OH
 - **(b)** С₂H₅OH₂
 - CH3CH2O
 - d CH₃OCH₃
- All the following are Brönsted Lowry acids, except
 - (a) CH₃COO
 - (b) HCO-
 - C HSO,
 - (d) NH₄⁺



- Which of the following pairs does not represent a conjugate acid and its base respectively?
 - (a) NH₄ , NH₃
- **(b)** H₂S , HS⁻
- © H₃O⁺, H₂O
- \bigcirc NH $_2$, NH $_3$
- Which of the following ions can not behave as a base and as an acid in different reactions?
 - (a) H₂PO₄

(b) CO₃²-

© HCO₃

- (d) HSO₄
- 15 Water acts as a Brönsted Lowry acid when it reacts with
 - d NH₃

(b) H2S

(C) HCN

- (d) HNO₃
- In the reaction: $CH_3COOH_{(aq)} + NH_{3(g)} = CH_3COO_{(aq)}^- + NH_{4(aq)}^+$ Which of the following represents the type of each of the reactants and the products respectively?

Choices	CH ₃ COOH _(aq)	NH _{3(g)}	CH ₃ COO _(aq)	NH ⁺ _{4(aq)}
(a)	Acid	Base	Conjugate base	Conjugate acid
(b)	Conjugate acid	Conjugate base	Acid	Base
(i)	Base	Acid	Conjugate base	Conjugate acid
(I)	Conjugate base	Conjugate acid	Acid	Base

In the reaction : $HCO_{3(aq)}^- + H_2O_{(l)} \longrightarrow OH_{(aq)} + H_2CO_{3(aq)}$

Which of the following represents the reactants and the products according to Brönsted-Lowry theory ?

Choices	Acid	Base	Conjugate acid	Conjugate base
(1)	HCO _{3(ас,})	$H_2O_{(j)}$	Н ₂ СО _{3(ыц,}	OH _(aq)
Ъ	$H_2CO_{3(aq)}$	OH (aq)	HCO _{3(aq)}	$H_2O_{(t)}$
0	$H_2O_{(\ell)}$	HCO _{3(aq)}	H ₂ CO _{3(aq)}	OH-(aq)
(1)	$H_2O_{(t)}$	HCO _{3(aq)}	OH _(aq)	H ₂ CO _{3(aq)}

- According to Brönsted Lowry theory, the mixture of water with nitric acid
 - (a) OH-
 - (b) NO₃
 - \bigcirc NO₃
 - \bigcirc NO $_2^-$



Sulphuric acid H₂SO₄ ionizes in water in two steps, represented by the two following equations:

-
$$H_2SO_{4(aq)} + H_2O_{(\ell)} \longrightarrow H_3O_{(aq)}^+ + HSO_{4(aq)}^-$$

•
$$HSO_{4(aq)}^- + H_2O_{(l)} \longrightarrow H_3O_{(aq)}^+ + SO_{4(aq)}^{2-}$$

What is the conjugate base of ${\bf HSO}^-_{4(aq)}$ ion ?

(a) H₂O_(l)

(b) H₃O⁺(aq)

© H₂SO_{4(aq)}

- (d) SO_{4(aq)}
- Bisulphate anion HSO₄ reacts in water as an acid and as a base.

 What is the reaction in which bisulphate anion acts as an acid?

(a)
$$HSO_4^- + H_2O \longrightarrow H_2SO_4 + OH^-$$

$$\bigcirc$$
 HSO₄⁻ + H₃O⁺ \longrightarrow SO₃ + 2H₂O

$$\bigcirc$$
 HSO₄ + OH \longrightarrow H₂SO₄ + O²

(d)
$$HSO_4^- + H_2^-O$$
 → $SO_4^{2-} + H_3^-O^+$



- $M = 10^{-5}$ The basicity of hydride anion H $^-$ is stronger than the basicity of hydroxide anion OH⁻, therefore, the reaction of H⁻ anion with water forms ...
 - (a) H₃O⁺_(aq)

- (b) $OH_{(a0)}^- + H_{2(a)}$
- © $OH_{(aq)}^- + 2H_{(aq)}^+$

Lewis theory



💯 📜 Lewis base

- (a) must be a neutral molecule.
- (b) must be a charged ion.
- (c) may be a neutral molecule or a charged ion.
- (d) must be a neutral atom.



🙉 🡥 All the Brönsted - Lowry bases are

- (a) Lewis bases.
- (b) Arrhenius acids.
- C Lewis acids.
- (d) Arrhenius bases.
- The following figure represents the two concepts of the acid and the base:



What is (are) the theory(ies) which explain(s) the two concepts of the acid and the base in this figure?

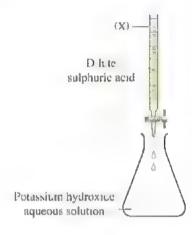
- (a) Arrhenius theory only.
- (b) Brönsted-Lowry theory only.
- (c) Arrhenius and Lewis theories.
- (d) Brönsted-Lowry and Lewis theories.



Uses and properties of acids and bases

25 Palmitic acid is found in almost all natural fats, known commercially as palm acid, while sodium bicarbonate is known commercially as baking soda How can you differentiate between palm acid and baking soda?

- 26 Write the balanced symbolic equation which represents the reaction of an acid with a base to form a salt formed of Mg²⁺ cations and Cl⁻ anions.
- 🜆 Study the opposite figure, then answer the following:
 - (1) What is the name of the tool (X)? Where is the zero mark located in its scale?
 - (2) Write the symbolic equation which represents the occurring reaction.
 - (3) Write the net ionic equation in the light of Arrhenius theory.



Theories defining acids and bases

Basic properties of the basic substances do not appear except when they are present with acidic substances.

What is (are) the theory(ies) which explain(s) the previous statement?

"The existence of H" ions in an aqueous solution causes a litmus paper to be red". What is the source of H ions in the aqueous solutions.

Is it an Arrhenius acid, a Bronsted Lowry acid or a Lewis acid?

Complete the following equation which illustrates the dissolution of hydrazine in water, knowing that it acts as a Brönsted - Lowry base:

In the equilibrium process: $SbF_5 + 2HF \Longrightarrow SbF_6^- + H_2F^+$

Illustrate the behaviour of HIP in this process according to Bronsted - Lowry theory.

💯 In the following overall ionic equation :

$$HC_2H_3O_{2(aq)} + Na_{(aq)}^+ + OH_{(aq)}^- \longrightarrow Na_{(aq)}^+ + C_2H_3O_{2(aq)}^- + H_2O_{(aq)}^-$$

- (1) Write the net ionic equation which represents this reaction.
- (2) Determine the conjugate base in this reaction.
- Determine the acid and the base in the reaction which is represented by the opposite equation.

trifluoride

New types of questions 2 Answered



Choosing two out of five choices questions :

- Which of the following substances represent the different concepts of acids and bases?
 - (a) H₂O represents a Brönsted Lowry base but not an Arrhenius base.
 - (b) KOH represents an Arrhenius base but not a Lewis base.
 - (c) NH₂ represents an Arrhenius base but not a Lewis base.
 - (d) H+ represents a Lewis acid and Arrhenius acid.
 - (e) HSO₄ represents an Arrhenius acid and a Brönsted Lowry acid.
- Which of the following can act as an acid and as a base according to Brönsted - Lowry?
 - (a) CH, COOH

(b) HS⁻

(c) NO₂

(d) H₂PO₄

- (e) OH
- Phosphine gas dissolves in water according to the reaction:

$$PH_{3(g)} + H_2O_{(f)} \implies PH_4OH_{(aq)}$$

Which of the following matches lewis theory of acids and bases?

- (a) H₂O is the acid, as it accepts a lone pair of electrons from phosphine.
- (b) H₂O is the acid, as it donates a lone pair of electrons to phosphine.
- (c) PH₃ is the acid, as it accepts a lone pair of electrons from water.
- (d) H₂O is the base, as it accepts a lone pair of electrons from phosphine.
- (e) PH, is the base, as it donates a lone pair of electrons to water.
- In the reaction : $HSO_{4(aq)}^{-} + NH_{3(g)} \longrightarrow SO_{4(aq)}^{2-} + NH_{4(aq)}^{+}$ Which of the following is correct?
 - (a) NH₄ acts as a Lewis base.
 - b SO₄² acts as a Brönsted Lowry base.
 - (c) NH₃ acts as a Lewis base.
 - (d) HSO₄ acts as a Brönsted Lowry base.
 - (e) NH3 acts as an Arrhenius base.



Lesson

From



Classification of a la

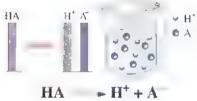
- Acids can be classified according to :
- Their strengths (degree of ionization).
- Their sources.
- Numbers of their basicity.



* Acids are classified according to their degree of ionization in water into:

Strong acids

Which are completely ionized in water

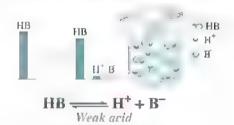


Strong acid

- Their aqueous solutions are good conductors of electricity.
- They are strong electrolytes.
- As all their molecules ionize in water.

Weak acids

Which are incompletely ionized in water



- Their aqueous solutions are bad conductors of electricity.
- They are weak electrolytes.
- As a small part of their molecules ionizes in water.

Examples]

 Carbonic acid H₂CO₃ Phosphoric acid H_3PO_4 Acetic acid CH₃COOH Formic acid. · Citric acid. Oxalic acid. Lactic acid.

HClO₄ Hydroiodic acid HI Hydrochloric acid HCl Hydrobromic acid HBr Sulphuric acid H_2SO_4 Nitric acid HNO₃

Perchloric acid

- * There is no relation between the strength of the acid and the number of hydrogen atoms in its molecular structure.
 - e.g. Phosphoric acid (H₃PO₄) is weaker than nitric acid (HNO₃), although it contains greater number of hydrogen atoms.

Worked Example

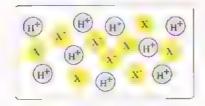
Write the chemical equation that expresses the ionization of acetic acid in water.

Answer:

$$CH_3COOH_{(aq)}$$
 + $H_2O_{(\ell)}$ \rightleftharpoons $CH_3COO_{(aq)}$ + $H_3O_{(aq)}^+$
Acetic acid Acetate ion Hydronium ion

. Fest bouset

The two following figures show the ionization of each of HX and HY acids :





Which of the following statements represents these two acids?

- (a) They both are weak acids.
- (b) They both are strong acids.
- (c) HX acid is strong, while HY is weak.
- (d) HX acid is weak, while HY is strong.

Answer: The correct choice is

Classification of acids according to their sources

* Acids are classified according to their sources (origins) into:

Organic acids

- Acids that have an organic origin (plant or animal).
 - of living organisms.
- All of them are weak acids.
- Lactic acid (milk products).
- Acetic acid (vinegar).
- Citric acid (from citrus plants).
- Oxalic acid.
- Formic acid (from ants).

Mineral acids

- · Acids that have no organic origin.
- i.e. They usually have a nonmetallic elements in their structures like chlorine, sulphur, nitrogen and phosphorus.
- Some of them are strong acids and others are weak.

Examples]

- Carbonic acid.
- Hydrochloric acid.
- Phosphoric acid.
- · Perchloric acid.
- · Nitric acid.
- Sulphuric acid.

Included information

Organic acids are characterized by containing – COOH group which is known as carboxyl group

The basicity of acid is the number of hydrogen ions (H⁺), which are produced by one molecule of the acid when it dissolves in water (the replaceable hydrogen atoms).

* Acids are classified according to their basicity into:

Monobasic acids (Monoprotic)

Acids where each molecule gives one proton H+ when it dissolves in water

Dibasic acids (Diprotic)

Acids where each molecule gives one or two protons H+ when it dissolves in water

Tribasic acids (Triprotic)

Acids where each molecule gives one, two or three protons H+ when it dissolves in water

Examples

- Organic monobasic acids :
 - Formic acid HCOOH
 - Acetic acid CH, COOH
- Mineral monobasic acids :
 - Hydrochloric acid HCl
 - Nitric acid HNO₃

• Organic dibasic acids:

Oxalic acid COOH COOH

- Mineral dibasic acids:
- Carbonic acid H₂CO₃
- Sulphuric acid H₂SO₄



H,SO, Dibasic acid

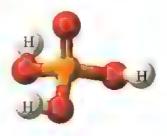
Organic tribasic acids :

Examples

Citric acid H₂C - COOH HO-C-COOH H₂C - COOH

Mineral tribasic acids :

Phosphoric acid H₃PO₄



H,PO Tribasic acid



Monobasic acid

Worked Example

The salts of the opposite acid are used in medicine and dyeing of fabrics. What is the similarity between this acid and sulphuric acid?

- (a) They both are dibasic.
- (c) They both are strong acids.

- HOOC-C-C-COOHOH OH
- (b) They both are organic acids.
- (d) They both are mineral acids.

Idea of answering:

- : The acid contains two (- COOH) groups.
- : Sulphuric acid is dibasic.
- Answer: The correct choice is (a)

- . The acid is dibasic.
- .. They both are dibasic.

Classification of bases

- * Bases can be classified according to:
 - Their strengths (degree of ionization or dissociation).
 - Their molecular structures.

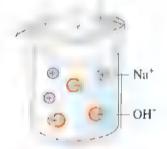
[1] Classification of bases ac selling to their strengths (degree of ionization or dissociation)

* Bases are classified according to their degree of ionization (dissociation) into :

Strong bases

Which are completely ionized in water

NaOH₍₈₎



Strong have NaOH

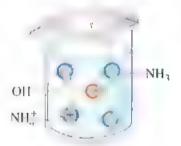
I mot of it dissociates in water yielding
I mot of OH lans

- Their solutions are good conductors of electricity.
- They are strong electrolytes.
- As all their molecules dissociate in water into ions.
- Potassium hydroxide KOH
- Sodium hydroxide NaOH
- Barium hydroxide Ba(OH)₂

Weak bases

Which are incompletely ionized in water

NH_{3(g)}



Weak base NII,
I mot of it ionizes partially in water yielding
very small number of OH* ions

- Their solutions are bad conductors of electricity.
- They are weak electrolytes.
- As a small part of their molecules ionizes in water into ions.

Examples

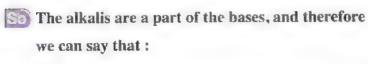
• Ammonium hydroxide NH₄OH



* Some substances react with acids forming salt and water, so these substances are considered as bases, as shown in the following table:

Bases	Examples	Applications
Metals oxides	Iron (II) oxide F=() Magnesium oxide \(\ = () \)	FeO _(s) + 2HCl _(aq) $\frac{dil}{dil}$ FeCl _{2(aq)} + H ₂ O _(l) Iron (II) Hydrochloric from (II) Water $\frac{dil}{dil}$ Water
Metals hydroxides	Calcium hydroxide Ca OH Sodium hydroxide NaOH	Calcium Sulphuric Sulphur
Metals carbonates	Potassium carbonate K_2(C)_3 Sodium carbonate Na ₂ CO ₃	K ₂ CO _{3(s)} + 2HCl _(aq) dil → 2KCl _(aq) + H ₂ O _(l) + CO _{2(g)} Potassium Hydrochloric Potassium Water Carbon di wilder gas
Metals bicarbonates	Potassium bicarbonate KH(++) Sodium bicarbonate NaHCO ₃	$\begin{array}{c} \text{KHCO}_{3(s)} + \text{HCI}_{(aq)} \xrightarrow{\text{dil.}} & \text{KCI}_{(aq)} + \text{H}_2\text{O}_{(l)} + \text{CO}_{2(g)} \\ \text{P.1.s. n. five octors.} & \text{P. a. s. t. five octors.} & \text{P. a. s. five octors.} & P. a. s. five$

* The base that dissolves in water is called Alkali which is the base that dissolves in water and gives hydroxide ion (OHT).



All alkalis are bases, but not all bases are alkalis.



The detection of acids and bases

- The aqueous solutions are divided into three types, which are :
 - Acidic solutions.
- · Alkaline solutions.
- Neutral solutions.
- * I'here are two methods for identifying these solutions :
 - 🕕 Indicators.

🏮 pH-meter.

This is a factor of the second of the second

Indicators are weak organic acids or bases, their colors change with the change of the solution (medium) type, this is attributed to the fact that the colour of the ionized indicator differs from that before ionization

- * Indicators are used in:
 - Identifying the type of solution (acidic, neutral, basic).
 - Determining the end point in titration processes between acids and bases.
- * The following table shows examples of some indicators and their colours in different media:

Indicator	Colour in acidic medium	Colour in neutral medium	Colour in basic medium
Methyl orange			A
	Red	Orange	Yellow
Phenolphthalein		N	
	Colourless	Colourless	Pink
Litmus	Red	Purple	Blue
Bromothymol blue	Yellow	Pale green	Blue



Worked Example

Colour of phenolphthalein changes with

- (a) HCl_(aq)
- **(b)** КОН_(аq)
- © H₂O_(f)
- d NaCl_(aq)

Idea of answering:

- : Phenolphthalein stays colourless in :
 - The acidic medium as HCl
- .. The choice (a) is excluded.
- Answer: The correct choice is (b)
- The neutral media as NaCl and H2O
- .. The choices © and d are excluded.

Enrichment information

Ant and bee bites have an acidic effect, and can be treated by using sodium bicarbonate (alkaline) solution, whereas those of the wasp and jelly fish have a basic effect and can be treated by using smegar (dilute acetic acid)

A. C.

The hydrogen exponent pH is a way to express the degree of acidity or alkalinity of a solution.

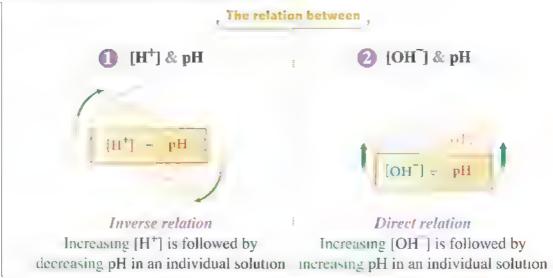
- The pH value is expressed by positive numbers range from (0 to 14).
- The pH value can be detected by :
 - The pH paper tape.
- The pH-meter.
- The pH value depends on the concentration of:
 - Positive hydrogen ions (H⁺).
 - Negative hydroxide ions (OII) in the solution, as follows:



pH-meter and pH paper tape

Acidic solution	Neutral solution	Basic solution
	OH OH OH	OH,
The concentration of	The concentration of	The concentration of
H ⁺ > OH	$H^+ = OH^-$	H ⁺ < OH
pH value < 7	pH value = 7	pH value > 7
PH<7 OH	Hr pH = 7 OH	pH>7

From the previous, it can be deduced that:



- * The opposite figure represents the pH - scale:
 - Vinegar, lemon and tomato juices are acidic substances (pH < 7),
 while pure water is
 a neutral substance (pH = 7).
 - Baking soda, detergents, toothpaste
 , sea water and egg white (albumin) are
 basic substances (pH > 7).
 - The strength of the acidic solution increases, as the value of pH approaches zero, while the strength of the basic solution increases, as the value of pH approaches 14



Viest Yourself

Which of the solutions shown in the opposite table has the highest pH?

(a) A

(b) В

© C

 \bigcirc D

Answer: The correct choice is

Solution	(A)	(B)	(C)	(D)
H ⁺ concentration (mol/L)	0.1	0.01	0.001	0.0001

Worked Example

The opposite graphical figure represents pH values of the wastes of a factory before and after adding substance (X).

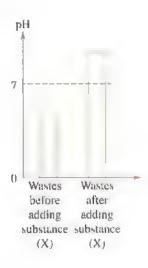
Which of these properties belongs to substance (X)?

- (a) It reacts with bases forming salt and water.
- (b) H⁺ ions concentration in it is higher than that of OH⁻ ions.
- (c) It reacts with acids forming salt and hydrogen gas.
- d lt changes the colour of methyl orange indicator into yellow.

Idea of answering :

- : Adding substance (X) to the wastes led to increasing pH above 7
- \therefore (X) is a base.
- :. The choices (a) and (b) are excluded.
- : Bases react with acids forming salts and water (not hydrogen gas).
- .. The choice (c) is excluded.

Answer: The correct choice is (d)





Answer them yourself

Choose the correct answer:

- (1) Among the strong acids is
 - a, acetic acid,
 - b, carbonic acid.
 - e, nitric acid.
 - d. citric acid.
- (2) All the following are mineral acids, except
 - a. sulphuric acid.
 - b. phosphoric acid.
 - c. citric acid.
 - d. hydrochloric acid.
- (3) Which of the following represents the chemical formula of acetic acid as well as its origin?

Choices	Formula	Origin
(il	CH ₃ COOH	Mineral
b	CH ₃ COOH	Organic
0	НСООН	Organic
	H ₃ PO ₄	Mineral

- (4) All the following acids are monobasic, except · ·
 - a acetic acid.
 - b. oxalic acid.
 - c, nitric acid.
 - d. hydrochloric acid.

- (5) All the following are properties of citric acid, except that it is a (an) · · · ·
 - a. organic acid.
 - b. weak acid.
 - c. tribasic acid.
 - d. dibasic acid.
- (6) All the following compounds are bases, except -
 - a. Na₂CO₃
 - b. Na₂O
 - c. NaNO3
 - d. NaOH
- (7) The pH value of a strong basic solution is
 - a. I
 - b. 5
 - c. 7
 - d. 13
- (8) The solution whose pH value equals 1 is
 - a. strong alkali.
 - b. weak alkali
 - c. strong acid.
 - d. weak acid

Complete the following table:

	Indicator	The color in acidic medium	The color in basic medium	The color in neutral medium
(1)	Methyl orange	*************		4+++44444444444444
(2)	**********	Yellow		
(3)	000000000000000000000000000000000000000	\$	44400000000000000000000000000000000000	Violet
(4)	\$\$\$\$\$\$\$\$\$	\$\$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$	Pink	***************

Open book questions

Answered





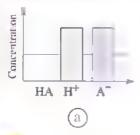
Classification of acids

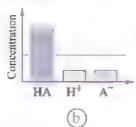
- Which of the following solutions that are equally concentrated has the highest ability to conduct electricity?
 - (i) H2S
- (h) H_2SO_4
- (C) H2SO3
- (d) H₂CO₃
- The test tube which contains sulphuric acid solution includes.
 - (a) H₂SO₄ molecules only.
 - b H₂SO₄ molecules, HSO₄ and H⁺ ions.
 - (c) HSO₄, SO₄ and H⁺ ions.
 - (d) H₂SO₄ molecules, HSO₄ and SO₄² ions.

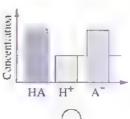


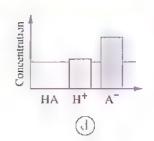
Which of the following graphical figures represents

the ionization of a weak monobasic acid HA?

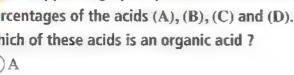


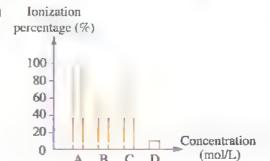






The opposite graph represents the ionization percentages of the acids (A), (B), (C) and (D). Which of these acids is an organic acid?



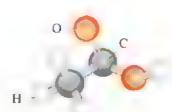


- (a)A
- (b) B

- What is the acid whose molecule contains 4 hydrogen atoms only one of them is a replaceable hydrogen atom?
 - (a) Sulphuric acid.
- (b) Acetic acid.
- (c) Formic acid.
- (d) Oxalic acid.



- 6 The acid which is illustrated in the opposite figure is classified as
 - (a) a strong monobasic acid.
 - (b) a weak monobasic acid.
 - (c) a weak tribasic acid.
 - d a strong tribasic acid.



- What is the mass of the precipitate which is produced from the reaction of 96 g of magnesium with excess phosphoric acid?
 - (a) 24 g

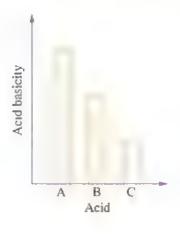
(b) 48 g

© 240 g

- (d) 349.3 g
- The opposite graphical figure represents the basicity of three acids, so if the acid (C) is hydroiodic acid.

 Which of the following represents the two acids (A) and (B) ?

Choices	Acid (A)	Acid (B)
a	Sulphuric	Carbonic
(b)	Hydrochloric	Nitric
0	Citric	Carbonic
d	Carbonic	Acetic



- Which of the following is the correct ascending order of these acids according to the number of basicity?
 - (d) Phosphoric acid < Oxalic acid < Hydrocyanic acid.
 - (b) Oxalic acid < Hydrocyanic acid < Phosphoric acid.
 - © Hydrocyanic acid < Oxalic acid < Phosphoric acid.
 - (d) Oxalic acid < Phosphoric acid < Hydrocyanic acid.

Classification of bases

- 10 Which of the following statements about acids and bases is correct?
 - (a) The base is a substance that donates positive hydrogen ions.
 - (b) The acid is a substance that accepts protons.
 - © The strong acid is almost 100% ionized.
 - d The weak acid does not react with strong bases.

In which reaction of the following it behaves as an acid?

©
$$3Zn(OH)_2 + 2H_3PO_4 \longrightarrow Zn_3(PO_4)_2 + 6H_2O$$

$$\bigcirc$$
 Zn(OH)₂ + H₂SO₄ \longrightarrow ZnSO₄ + 2H₂O

The detection of acids and bases

- All the following are correct for ammonia solution, except that it
 - a) is incompletely ionized.
 - b has pH value higher than 7
 - (c) has a boiling point less than that of pure water.
 - (d) is basic.
- Which of the following represents the expected results of hydrochloric acid on adding sodium bicarbonate to it, as well as adding two drops of litmus indicator to another sample of it?

Choices	Reaction with sodium bicarbonate	Formed colour with litmus
a	Reacts	Red
b	Reacts	Blue
0	No reaction	Red
(1)	No reaction	Blue

- On reaching the neutralization point in a titration process, the colour changes from ...
 - (a) orange to red.
- (b) yellow to green.
- colourless to pink.
- d blue to red.
- Which of the following indicators becomes yellow when it is added to a solution whose pH value is 10?
 - (a) Methyl orange.
- (b) Bromothymol blue.
- (c) Phenolphthalein.
- d Litmus.
- One of the chemical indicators which you have studied becomes yellow in the basic medium.

What is the colour that would appear in each of solution (A) whose pH is 3, and solution (B) whose pH is 7?

Choices	Colour in solution (A)	Colour in solution (B)
a	Red	Purple
(b)	Orange	Red
0	Red	Orange
(1)	Purple	Blue

- Which of the following statements represents correctly a colourless solution with pH 9?
 - (a) H⁺ ions concentration in it is higher than that of OH ions, and gives blue colour with litmus indicator,
 - (b) H⁺ ions concentration in it is higher than that of OH⁻ ions, and gives orange colour with methyl orange.
 - H⁺ ions concentration in it is lower than that of OH ions, and gives blue colour with litmus indicator.
 - (1) H⁺ ions concentration in it is lower than that of OH tons, and gives red colour with methyl orange.
- On testing an aqueous solution with methyl orange and phenolphthalein indicators, they gave the results which are illustrated in the opposite table.

Phenolphthalein		Pink	
Methyl orange	1	Yellow	_
Indicator		Colour	

What is the approximate value of pH of this solution?

(a) 6

(b) 7

(c) 2.7

(d) 11.7

- Which of the following solutions contains the highest concentration of hydronium ions?
 - a I M H₂CO₃ solution.

(b) Pure water.

© 1 M HCl solution.

- d 1 M NH₃ solution.
- The following table shows data about three different indicators:

Indicator	The colour at (pH = 1)	pH value at which the colour changes	The colour at $(pH = 12)$
(X)	Red	3	Yellow
(Y)	Red	5	Blue
(Z)	Colourless	10	Pink

, so if the liquid (W) yields a yellow solution with the indicator (X), a blue solution with (Y) and it yields a pink solution with (Z).

Which of the following statements represents the liquid (W)?

(a) Pure water.

(b) Hydrochloric acid solution.

© Its pH is 3 at least,

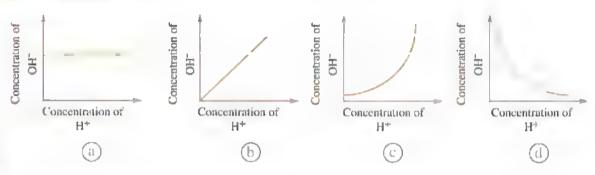
d Sodium hydroxide solution.

- Which of the following is a property of the weak acidic aqueous solution only?
 - (a) It changes the colours of all chemical indicators.
 - (b) It has pH value less than 7 and higher than 2
 - © It reacts with ammonium salts forming ammonia gas.
 - d It reacts with all bases forming salt and water only.
- Which of the following equally concentrated solutions has the lowest pH value?
 - (a) Ammonia solution.
 - (b) Acetic acid solution.
 - (c) Lithium hydroxide solution.
 - (d) Nitric acid solution.
- pH value of 0.1 M NaOH solution =
 - (a) 0.1
 - (b) 1
 - (c) 8
 - (d) 13
- On adding distilled water to a test tube contains sulphuric acid whose pH value = 2, it is possible that pH of the dilute solution becomes
 - (a) 2
 - (b) 3
 - (c) 7
 - (d) 8
- The concentration of H⁺ ions in formic acid differs from that in hydrochloric acid, and also their pH values are different when they are equally concentrated.

 Which of the following expresses formic acid compared to hydrochloric acid?

Choices	H ⁺ ions concentration	pH value
(a)	Higher	Higher
Ъ	Higher	Lower
0	Lower	Higher
<u>d</u>	Lower	Lower

What is the graphical figure which represents correctly the relation between the concentration of H⁺ ions, and that of OH⁻ ions in the same aqueous solution at constant temperature?



- Which of the following statements represents correctly two solutions of sodium hydroxide and ammonia that have equal volumes and concentrations?

 Sodium hydroxide solution
 - (i) has lower ability to conduct electricity than ammonia solution.
 - (b) contains H⁺ ions concentration higher than that in ammonia solution.
 - (c) has pH value higher than that of ammonia solution.
 - (1) contains OH ions concentration lower than that in ammonia solution.
- On adding drops of methyl orange indicator to each of (X) and (Y) solutions, the colour of (X) becomes red, while that of (Y) becomes yellow.

 Which of the following represents both the pH value, and H⁺ concentration in solution (X) relative to solution (Y)?

Choices	pH value of solution (X) is lower than that of solution (Y)	H ⁺ concentration in solution (X) is lower than that in solution (Y)	
a	✓	✓	
0	✓	X	
0	×	✓	
(1)	×	Х	





Classification of acids

In the opposite table :

Which of the two acids (X), (Y) represents a monobasic weak acid?

Explain.

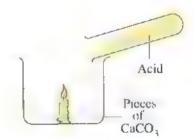
Acid	Before dissolving in water	After dissolving in water
(X)	8 00 g 8 00 g 00	
(Y)	8 8 8 00 0 8 9	6 0 8 00 0 9 00

- Formic acid was extracted for the first time from ants, so it is called formic (formica in latin means ants).
 - (1) Why is formic acid an organic acid?
 - (2) Is the aqueous solution of formic acid a good electrical conductor? Explain.
- Periodic acid is a weak acid, while perchloric acid is a strong acid:
 - (1) Write the empirical formula of perchloric acid.
 - (2) Mention a similarity between the two acids.

Classification of bases

- The opposite figure represents an experiment that is carried out using two different acids, which are: (1 M) HCl acid.
 - (1 M) CH₃COOH acid.

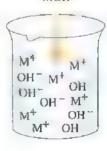
Which of the two acids would result in faster extinguishing of the candle flame? Give reason.



HO-C1 0 HO-1 0

MOH

- The opposite figure represents the dissolution of MOH in water.
 - (1) Which theory of those which describe acids and bases can explain the behaviour of the substance MOH in water?
 - (2) What is the difference between the aqueous solution of the substance MOH and that of ammonium hydroxide?



These are 3 positive ions and 5 negative ions :

Positive ions	Negative ions		
H^+, K^+, NH_4^+	SO_4^{2-} , CH_3COO^- , CO_3^{2-} , OH^- , NO_3^-		

Use the previous ions to write the chemical formulas of the following compounds:

(1) Organic acid.

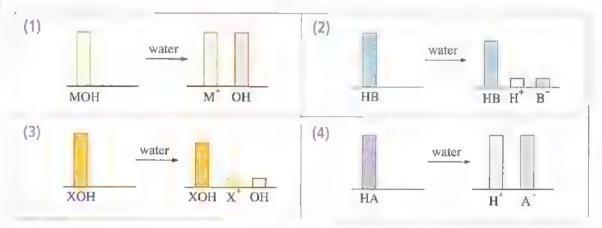
- (2) Weak base.
- (3) Strong dibasic mineral acid.
- (4) Strong base.

(5) Monobasic mineral acid.

(6) Weak dibasic mineral acid.

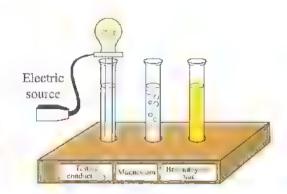
The detection of acids and bases

The following figures represent the change in the concentrations of 4 compounds which are acids and bases on dissolving in water:



Write the number of the figure which represents the ionization of

- (1) Ammonia solution.
- (2) A compound whose pH = 1
- (3) The compound which reacts slowly with magnesium.
- (4) A compound whose pH = 13
- The opposite figure represents three experiments carried out on one solution whose concentration is 1 M to test its electrical conductivity, as well as its reactivity with magnesium and the colour which it gives with bromothymol blue indicator:



- (1) Is this solution acidic or basic?
 - How can this be indicated?
- (2) Is this solution strong or weak? How can this be indicated?

New types of questions ?___



Choosing	two	out	of	five	choices	questions	:
----------	-----	-----	----	------	---------	-----------	---

	_	·					
1	Which of the following	acidic substances is polyprotic?					
	(a) CHO ₂	(b) NH ₄ +	© H ₃ PO ₄				
	d HCOOH	© C ₂ H ₂ O ₄					
2	Phosphoric acid resem	bles citric acid in that they both a	are				
	a strong acids.	(b) organic acids.					
	© weak acids.	d mineral acids.	e triprotic acids.				
3	Which of the following	is an ion formed from the ioniza	tion of a monoprotic acid?				
	a HS ⁻	(b) NO ₃	© HCO ₃				
	\bigcirc H ₂ PO $_4^-$	© CH ₃ COO ⁻					
4	Both iron (II) oxide an	d calcium oxide are					
	a bases.						
	(b) alkalis.						
	© react with acids for	ming salt and water.					
	d react with acids and	l hydrogen gas evolves.					
	e nonmetal oxides.						
5	The colour of phenolp	hthalein does not change in the t	wo solutions				
	а кон	(b) HCl	© NaCl				
	ⓓ KHCO₃	© NH ₄ OH					
6	The chemical indicator	(X) is added to a solution its pH	is 5.6				
	Which of the following	g can be the chemical indicator (X) ?				
1	What is the colour whi	ich the indicator gives in this solu	tion ?				
	a Methyl orange and	gives yellow colour.					
	(b) Phenolphthalein and gives pink colour.						
	© Litmus indicator an						
,	·	and gives yellow colour.					
	(e) Litmus indicator an	d gives purple colour.					



Salts are found abundantly in earth's crust



They are also found dissolved or precipitated in sea water



Salt formation: Any salt is formed of two radicals, as follows:



A positive ion (M⁺)
of the base
(basic radical)

Anion X

A negative ion (X)
of the acid
(acidic radical)





استنبال

Formation of potassium nitrate salt:

Cation
Basic radical) >

Anion (1 c radical)

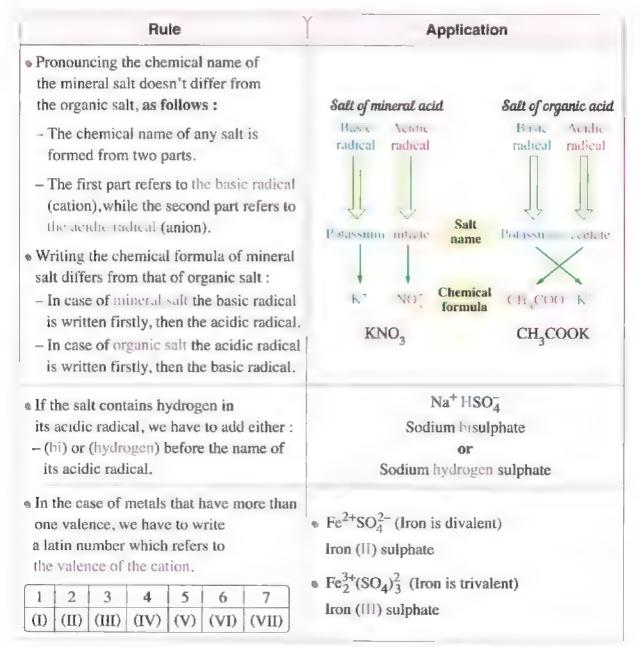


• When potassium hydroxide reacts with dil. nitric acid, potassium nitrate salt is produced:

$$K^+OH^-$$
 + $H^+NO_{3(aq)}$ - $K^+NO_{3(aq)}$ + $H_2O_{(l)}$
Potassium Nıtric Potassium Water hydroxide acid nîtrate

The chemical formulas of salts and their imming

 There are some rules should be considered during writing the formulas of the salts and naming them, as shown in the following table:



* The chemical formula of the salt depends on :

- The acid which represents the source of the anion.
- The valence of the amon and cation.

The acid	Anion 🚓	Cation	Salt	
UNG	No	K ⁺	Potassium nitrate KNO ₃	
HNO ₃ Nitric	Nitrate anion	Pb ²⁺	Lead (II) nitrate Pb(NO ₃) ₂	Nitrate Salts
acid		Fe ³⁺	Iron (III) nitrate Fe(NO ₃) ₃	
ttel	OI=	Na ⁺	Sodium chloride NaCl	
HCl Hydrochloric acid	Cl Chloride	Mg ²⁺	Magnesium chloride MgCl ₂	Chloride Salts
acid	anion	A1 ³⁺	Aluminum chloride AlCl ₃	1
CII COOII		K ⁺	Potassium acetate CH ₃ COOK	
CH ₃ COOH Acetic	CH ₃ COOT Acetate anion	Cu ²⁺	Copper (II) acetate (CH ₃ COO) ₂ Cu	Acetate Salts
acid		Fe ³⁺	Iron (III) acetate (CH ₃ COO) ₃ Fe	
	HSO ₄	Na ⁺	Sodium sulphate Na ₂ SO ₄	Sulphate
H ₂ SO ₄ Sulphuric		Cu ²⁺	Copper (II) sulphate CuSO ₄	Salts
acid		Na ⁺	Sodium bisulphate NaHSO ₄	Bisulphate
	Bisulphate anion	Al ³⁺	Aluminum bisulphate Al(HSO ₄) ₃	Salts
	CO ₃ ²⁻	Na ⁺	Sodium carbonate Na ₂ CO ₃	Carbonate
H ₂ CO ₃ Carbonic	Carbonate anion	Ca ²⁺	Calcium carbonate CaCO ₃	Salts
	HCO ₃	Na ⁺	Sodium bicarbonate NaHCO3	Bicarbonate
	Bicarbonate -	Mg ²⁺	Magnesium bicarbonate Mg(HCO ₃) ₂	Salts

Note |

ΓeCl₃ is called iron (III) chloride, while AlCl₃ is called aluminum chloride, although the valence of both iron and aluminum is 3 in both salts, because iron has two valences (Fe²⁺ and Fe³⁺), while aluminum is trivalent only (Al³⁺)

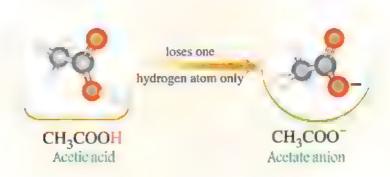
* It is obvious from the previous table that :

Some acids have more than one type of salts, basing on the number of the replaceable hydrogen atoms in the acid molecule, thus:

* 11 . . .

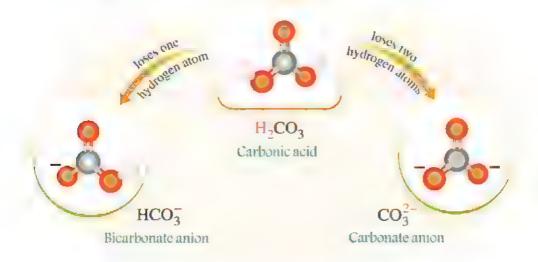
1 replaceable hydrogen atom, such as :

- Nitric acid HNO₃ → Forms nitrate salts only.
- Hydrochloric acid HCl → Forms chloride salts only.
- Acetic acid CH₃COOH → Forms acetate salts only.



2 replaceable hydrogen atoms, such as:

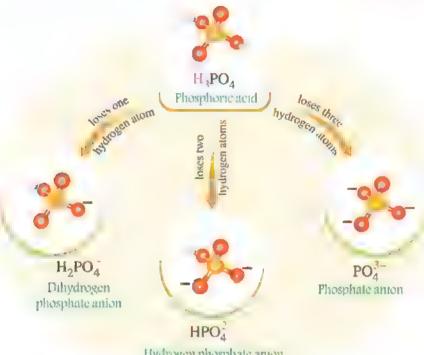
- Sulphuric acid H₂SO₄ → Forms bisulphate and sulphate salts.
- Carbonic acid H₂CO₃ Forms bicarbonate and carbonate salts.





3 replaceable hydrogen atoms, such as :

Phosphoric acid (H₃PO₄) forms three types of salts:



Hydrogen phosphate amon

Worked Example

Use the following acidic and basic radicals to write the chemical formulas of the salts produced by their combinations, then mention their names:

$$(Ba^{2+}\ /\ Ca^{2+}\ /\ NH_4^+\ /\ NO_3^-\ /\ SO_4^{2-}\ /\ C\Gamma)$$

Answer:

Basic radical	NO ₃	SO ₄ ² -	CIT
	Nitrate anion	Sulphate anion	Chloride anion
Ba ²⁺ Barium cation	Ba(NO ₃) ₂ Barium nitrate	BaSO ₄ Barium sulphate	BaCl ₂ Barium chloride
Ca ²⁺ Calcium cation	Ca(NO ₃) ₂ Calcium nitrate	CaSO ₄ Calcium sulphate	CaCl ₂ Calcium chloride
NH ₄ ⁺ Ammonium cation	NH ₄ NO ₃	(NH ₄) ₂ SO ₄	NH ₄ Cl
	Ammonium nitrate	Ammonium sulphate	Ammonium chloride

Salt formation methods

- * Salts can be practically prepared by one of the following methods:
 - Reaction of active metals with dilute acids.
 - Reaction of metals oxides with dilute acids.
 - Reaction of metals hydroxides with dilute acids.
 - Reaction of metals carbonates or bicarbonates with dilute acids.



Active metal + Acid - Salt of acid + Hydrogen gas

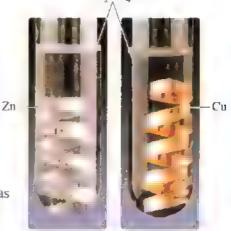
- The metals which lie above hydrogen in the chemical activity series (remember) replace hydrogen in the dilute acid solutions, giving salt of acid and hydrogen gas evolves which burns with a pop sound when a lit splint is exposed to it.
- If the produced salt of the acid dissolves in water, so it can be separated by heating the solution, where water evaporates and the salt remains.

Application

Reaction of zinc with dilute sulphuric acid.

$$Zn_{(s)} + H_2SO_{4(aq)}$$
 \longrightarrow $ZnSO_{4(aq)} + H_{2(g)}$

Zinc Sulphuric acid $Zinc$ sulphate Hydrogen gas



H₂SO₄

Zinc reacts with dilute sulphuru acid while copper does not react with it

Reaction of metals mide with dilute mide

Metal oxide + Acid dil Salt of acid + Water

- This method is used if there is a difficulty in the direct reaction of metal with acid, because:
 - The reaction is dangerous (e.g. reaction of sodium with hydrochloric acid is vigorous and causes an explosion).
 - The metal doesn't react with the acid, because it is less active than hydrogen (e.g. copper doesn't react with hydrochloric acid).



Reaction of copper (II) oxide with dilute sulphuric acid.

$$CuO_{(s)}$$
 + $H_2SO_{4(aq)}$ dil $CuSO_{4(aq)}$ + $H_2O_{(l)}$
Copper oxide Sulphuric acid Copper sulphate Water

Reaction of metals hydroxides with cilute acids

Metal hydroxide (alkali) + Acid - dil Salt of acid + Water

- This method is applicable for metal hydroxides which are soluble in water (alkalis) only.
- These types of reactions are known as
- Neutralization reaction can be used in analytical chemistry to estimate the unknown concentration of an acid (or a base) using a base (or an acid) with a known concentration in the presence of a suitable indicator.



Titration process by using a variable indicator

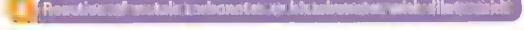
Neutralization point (end point) is the point at which
the amount of acid is equivalent to the amount of alkali which
is indicated by the change of the colour of the used chemical indicator.





Neutralization of sodium hydroxide with dilute hydrochloric acid.

 $NaOH_{(aq)}$ + $HCl_{(aq)}$ - $MaCl_{(aq)}$ + $H_2O_{(l)}$ Sodium Hydrochloric Sodium Water hydroxide



Metal carbonates (or bicarbonates) + Acid _dil_ Salt of acid + Water + Carbon dioxide gas

- Metals carbonates or bicarbonates are salts of carbonic acid which is an unstable acid, due to its low boiling point.
- It is possible for any other acid (that is more stable than it such as hydrochloric acid) to replace it in its salt solutions to form the salt of the stronger acid and the unstable carbonic acid.
- Carbonic acid decomposes in turn into water and carbon dioxide gas, which turns clear limewater milky after passing for short time in it.



Reaction of sodium carbonate salt with dilute hydrochloric acid.

$$Na_2CO_{3(s)}$$
 + $2HCl_{(aq)}$ \xrightarrow{dil} $2NaCl_{(aq)}$ + $H_2O_{(\ell)}$ + $CO_{2(g)}$ | Sodium Water Carbon carbonate acid chloride dioxide gas

Note

The reaction of metal carbonates or bicarbonates with some acids is called "acidity test", because this reaction is used to detect the presence of the acids, as a strong effervescence occurs due to the evolution of CO₂ gas, which turns clear limewater turbid.

Types of aqueous solutions of salts

* The type of the salt solution depends on the acid and the base (alkali) forming it, as shown in the following table:

Base	Acid =	⇒ Sait	Type of salt solution
NaOH (strong)	HCl (strong)	NaCl	Neutral
NH ₄ OH	CH ₃ COOH	CH ₃ COONH ₄	pH = 7
NH ₄ OH (weak)	HCl (strong)	NH ₄ Cl	Acidic pH < 7
NaOH (strong)	H ₂ CO ₃ (weak)	Na ₂ CO ₃	Basic pH > 7



- (1) The aqueous solution of potassium nitrate KNO₃ is neutral, because KNO₃ is produced from the reaction of a strong acid (HNO₃) with a strong base (KOH). So the pH value is 7
- (2) The pH value of an aqueous solution of ammonium acetate CH₃COONH₄ equals 7, because this solution is neutral, where CH₃COONH₄ is produced from the reaction of a weak acid (CH₃COOH) with a weak base (NH₄OH).
- (3) The pH value of an aqueous solution of ammonium chloride NH₄Cl is less than 7, because this solution is acidic, where NH₄Cl is produced from the reaction of a strong acid (HCl) with a weak base (NH₄OH).
- (4) The aqueous solution of sodium carbonate Na₂CO₃ is basic, because Na₂CO₃ is produced from the reaction of a strong base (NaOH) with a weak acid (H₂CO₃). So its pH value > 7

	1	
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Test Yourself

By using these ions:

[K⁺/NH₄⁺/SO₄²⁻/HCOO⁻]

Predict the chemical formula of the compound which dissolves in water forming:

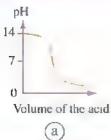
- (1) A salt solution that increases the acidity of the soil.
- (-----)
- (2) A salt solution that changes the colour of phenolphthalein.
- (.....)

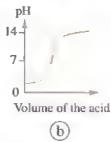
(3) A solution whose pH is 7

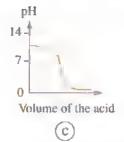
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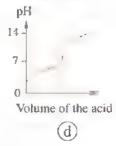
Warked Example

What is the curve which represents the titration of a weak base with a strong acid?









Idea of answering:

- : The solution in the flask, before starting the titration process, is a weak base.
- : Its pH is slightly higher than 7 (lower than 14).

Answer: The correct choice is (c)

The solution with the highest pH value is produced from the neutralization of

(a) HCl with NH4OH

(b) HNO2 with KOH

© HCl with Na₂CO₃

(d) HNO3 with NaOH

Idea of answering:

HCl	VH ¹ OH	HNO_2	KOH	Na ₂ CO ₃	HNO'	NaOH
Strong	Weak	Weak	Strong	Weak	Strong	Strong
acid	base	acid	base	base	acid	base

* pH value is the highest in the strong basic solutions produced from the neutralization of acid with base.

Answer: The correct choice is . . .

Questions



c. CH₃COONa

elf

Acres	The state of the s	Answer them yours
Choose	the correct answer:	
(1) The a	nion of sodium hydrogen c	arbonate salt is
a. HC		b. CO ₃ ²⁻
c. HS	3	d. SO_4^{2-}
	h of the following acids for	
	osphoric acid.	b. Carbonic acid.
c. Sul	phuric acid.	d. Nitric acid.
(3) Salts	are formed when acids read	et with each of the following, except
a. alk		b. metals carbonates.
c. me	tals oxides.	d. nonmetals oxides.
(4) Acids	react with active metals ar	ıd
a. NH	I ₃ gas evolves.	b. N ₂ gas evolves.
c. CO	gas evolves.	d. H ₂ gas evolves.
(5) Copp	er (II) sulphate salt is not p	repared from the reaction of sulphuric acid with.
a. cop	oper.	b. copper (II) oxide.
c. cop	oper (II) carbonate.	d. copper (II) hydroxide.
(6) In the	acidity test, the evolved ga	as is
a. H ₂		b. O ₂
c. CO	2	d. CO
(7) Whic	h of the following salts diss	solves in water forming an acidic solution?
a. NF	I ₄ Cl	b. NaCl

d. Na₂CO₃

(8) The	pH val	ue of CH	3COONH	4 solution	equals
---------	--------	----------	--------	------------	--------

a. zero

b. 3

c.7

d. 14

(9) Which of the following salts has an alkaline effect on litmus indicator?

a. NH₄Cl

b. K2CO3

c. NaNO₃

d. KCl

(10) On adding phenolphthalein to the aqueous solution of ammonium chloride salt, the color of the solution becomes

a. red.

b. colorless.

c. yellow.

d. blue.

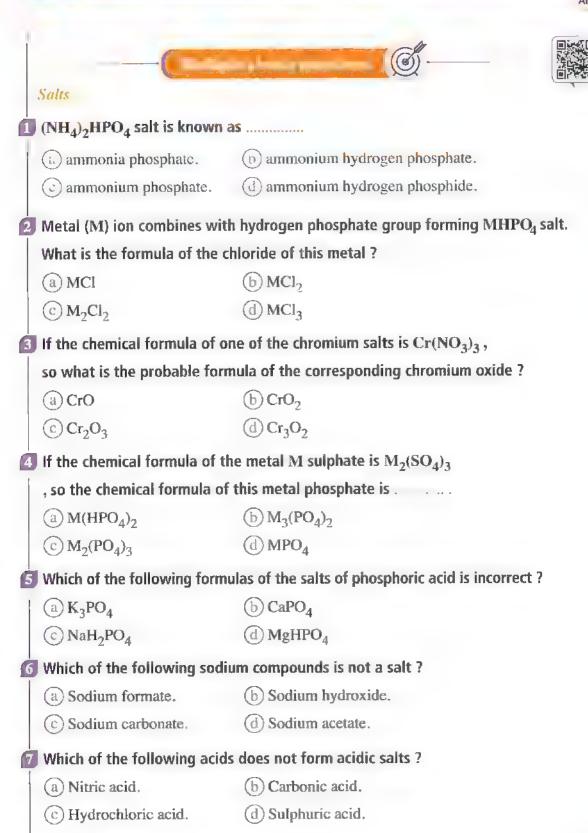
2 Give reasons for:

- (1) FeCl₂ is called iron (II) chloride, while MgCl₂ is called magnesium chloride, although the two cations in both salts are divalent.
- (2) The pH value of the aqueous solution of ammonium carbonate equals 7



Open book questions

Answered:



Salt formation methods

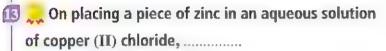
- In which of the following reactions a pipette and a burette are used in preparing the salt?
 - (1) The reaction of calcium carbonate with nitric acid to form calcium nitrate.
 - (II) The reaction of copper (II) oxide with sulphuric acid to form copper (II) sulphate.
 - The reaction of potassium hydroxide with hydrochloric acid to form potassium chloride.
 - d The reaction of zinc with hydrochloric acid to form zinc chloride.
- Magnesium sulphate crystals are prepared from the reaction of dilute sulphuric acid with excess of magnesium oxide in two steps, which are
 - (a) decomposition and filtration. (b) decomposition and oxidation.
 - neutralization and evaporation (1) neutralization and oxidation.
- 10 Which of the following substances are used in the titration processes?
 - (a) An acid which is insoluble in water with a base which is insoluble in water.
 - An acid which is insoluble in water with a base which is soluble in water.
 - © Water soluble acid with water insoluble base.
 - d Water soluble acid with water soluble base.
- 11 ___ The opposite figure represents a chemical experiment, in which
 - (1) neutralization and precipitation processes take place.
 - b only neutralization process occurs.
 - c only precipitation process occurs.
 - (d) an oxidation-reduction process takes place.

Dil. sulphuric

Barium hydroxide

19.2 mL of 0.1 M hydrochloric acid are added
to 25 mL of sodium hydroxide solution in a titration
process to estimate the concentration of sodium hydroxide solution.
What are the tools required to measure the volumes of the two liquids accurately?

el .		
Choices	Acid	Alkali
(al)	Burette	Graduated cylinder
b	Burette	Burette
0	Pipette	Graduated cylinder
(1)	Pipette	Burette



- (a) no change in the concentrations of the ions occurs.
- (b) Cl ions concentration increases.
- © Cu²⁺ ions concentration increases.
- (d) Zn²⁺ ions concentration increases.



Which of the following ions produces gas bubbles on adding hydrochloric acid to its solid salt ?

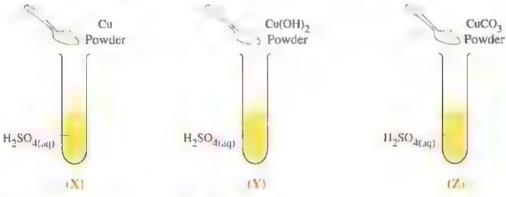
(a) Cu²⁺

(h) Fe³⁺

(c) Al3+

(d) CO₃²

The following figures represent three different experiments, during which three different powders are added to dilute sulphuric acid with stirring.



Which of these tubes contains $Cu_{(aq)}^{2+}$ ions ?

- (a) X and Y only.
- (b) X and Z only.
- © Y and Z only.
- (d) X, Y and Z

4 equal volumes of 0.1 M hydrochloric acid are added to 4 test tubes contain equal pieces of copper, iron, magnesium and zinc in no particular order.

Which of these tubes contains copper metal?







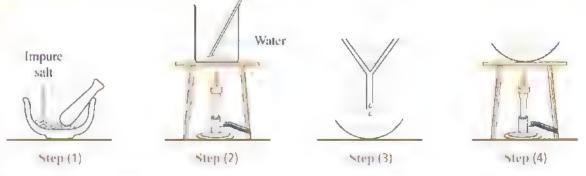




- Magnesium chloride can be prepared by the reaction of dilute hydrochloric acid with
 - (a) magnesium carbonate or magnesium oxide only.
 - (b) magnesium or magnesium oxide only.
 - (c) magnesium or magnesium carbonate only.
 - magnesium, magnesium carbonate or magnesium oxide.



is 🚚 The following figures represent the steps of preparation of one of the salts :



Which of the following salts can not be prepared by this method?

- Barium sulphate.
- (b) Copper (II) sulphate.
- © Sodium sulphate.
- (d) Sodium chloride.

Types of aqueous solutions of salts

- - (a) basic substance.
- (b) amphoteric substance.
- (c) acidic substance.
- (d) neutral substance.
- Which of the following substances dissolves in water forming 1 M solution which has the minimal pH value ?
 - (a) Ammonium chloride.
- (b) Ammonium acetate.
- © Sodium acetate.
- d Sodium chloride.
- The ions $(K^+/CN^-/Br^-)$ can produce two types of salts.

Which of the following are the probable pH values of these two salts?

(a) 3 and 5

(b) 7 and 12

© 3 and 7

(d) 9 and 11

- The following solutions are equally concentrated.

 What is the correct graduation of their pH values?
 - (a) NaCl < NH₄Cl < NaCN < HCl
- (b) HCl < NH₄Cl < NaCl < NaCN
- © NaCN < NH₄Cl < NaCl < HCl
- (1) HCl < NaCl < NaCN < NH₄Cl
- On mixing two equal volumes of H₂SO₄ and NaOH solutions, each of 1 M concentration, the produced solution
 - (a) is acidic.
- (b) has pH = 7
- © is alkaline.
- (d) has pH > 7
- Among the well known ions are : $(C\Gamma/SO_4^{2-}/CH_3COO^-/K^+/NH_4^+)$

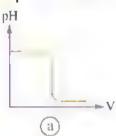
Which of the following two salts the pH values of their solutions are less than 7?

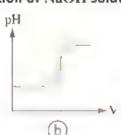
(II) NH₄Cl , CH₃COOK

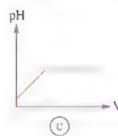
(b) (NH₄)₂SO₄ , NH₄Cl

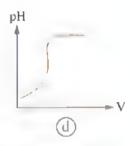
C K2SO4 , KCI

- (d) CH₃COONH₄, K₂SO₄
- What is the graphical figure which represents
 the process of the addition of NaOH solution to HCl solution?









- Which of the following salt solutions contains hydroxide ions in concentration higher than that of hydrogen ions?
 - (1) Ba(NO₃)₂
- (b) NaClO₄
- © CH₂COOK
- (d) CuSO₄
- The value of pH of an aqueous solution of hydrochloric acid = 2

 What is the value of pH of the solution which is produced from adding 10 g of NaCl to this acid?
 - (a) pH = 1
- (b) pH = 2
- \bigcirc pH = 7
- (d) pH = 9
- Passing or the dissolution of some compounds in pure water changes the pH value.

 Which of the following is incorrect?

Choices	The substances added to water	The change in pH value
a	CO ₂	Decreases below 7
Ь	Na ₂ CO ₃	Rises above 7
0	NaCl	Rises above 7
d	NH ₄ C1	Decreases below 7

What is the solution which acquires red colour when drops of methyl orange are added to it?

- (a) Sodium carbonate solution.
- (b) Sodium chloride solution.
- (c) Ammonium chloride solution.
- (1) Potassium hydroxide solution.



Salt formation methods

- Write the balanced symbolic equation which indicates the preparation of rubidium sulphate salt which is soluble in water using rubidium hydroxide RbOH which dissolves in water.
- Convert the following ionic equation into a symbolic equation :

$$MgO_{(s)} + 2H_{(aq)}^{+} \longrightarrow Mg_{(aq)}^{2+} + H_2O_{(\ell)}$$

The following compounds are used as fertilizers:

$$[NH_4NO_3 - (NH_4)_3PO_4 - (NH_4)_2SO_4]$$

Which of these fertilizers does not affect the acidity of the soil? Explain.

Types of aqueous solutions of salts

What is the formed colour on adding drops of :

- (1) Bromothymol blue indicator to sodium chloride solution.
- (2) Phenolphthalein indicator to sodium carbonate solution.
- (3) Litmus indicator to ammonium acetate solution.

🗿 How can you differentiate practically between 🕆

- Ammonium acetate solution and ammonium chloride solution "using methyl orange indicator".
- (2) Ammonium nitrite solution, ammonium hydroxide solution and ammonium sulphate solution "using bromothymol blue indicator".

Methylamine CH3NH2 is a weak base:

- (1) Write the equation of dissolving methylamine in water according to the concept of Brönsted-Lowry.
- (2) What is the type of the salt which is produced from the reaction of methylamine with sulphuric acid? Explain.

- Choosing two out of five choices questions:
- All the following are correct chemical formulas of the compounds, except

Choices	Compound	Chemical formula
(a)	Copper (II) nitrate	Cu(NO ₃) ₂
(b)	Calcium acetate	(CH ₃ COO) ₂ Ca
©	Aluminum sulphate	Al(HSO ₄) ₃
<u>d</u>	Magnesium carbonate	MgCO ₃
(e)	Iron (II) fluoride	Fe ₂ F

2	The following solutions	are equal in concentration,	which of them is alkaline?

(a) LiCI

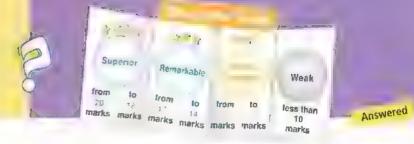
(b) K₃PO₄

© NaClO₄

(d) NH₄NO₃

- (e) HCOONa
- The colour of litmus indicator does not change when it is added to
 - (a) LiF solution.
- (b) CrCl₃ solution.
- © KNO3 solution.
- (d) NH₄Cl solution.
- © CH₃COONH₄ solution.

Exam model on Unit 3



Choose the correct answer for the questions (









What is the mass of NaOH (its molar mass = 40 g/mol) which is found in 500 mL of 0.175 M sodium hydroxide solution ?

- (a) 3.5 g
- (b) 3.5×10^3 g
- © 14 g
- (1) 114 g

All the following statements are correct, except

- (a) increasing temperature leads to increasing solubility of most of the solid substances.
- (b) polar substances dissolve in organic solvents.
- nonpolar substances do not usually dissolve in water.
- d the vapour pressure of the aqueous solution of Na₂SO₄ is lower than the vapour pressure of its pure solvent.

Which of the following is formed by the dispersion of a gas in a liquid?

- (a) Milk.
- (b) Aerosol.
- © Gel.
- (d) Whipped cream.

Which of the following choices represents the conjugate acid and the conjugate base of dihydrogen phosphate anion $H_2PO_4^-$?

Choices	Conjugate acid	Conjugate base
(a)	HPO ₄ ²⁻	H ₃ PO ₄
b	H ₃ PO ₄	HPO ₄ ²⁻
0	H ₃ O ⁺	PO ₄ ³⁻
(1)	PO ₄ ³ -	H ₃ O ⁺



- acetic acid is an organic acid, while sulphuric acid is a mineral acid.
- (b) acetic acid is dibasic, while sulphuric acid is monobasic.
- acetic acid is a strong electrolyte, while sulphuric acid is a weak electrolyte.
- d acetic acid is water insoluble, while sulphuric acid is water soluble.

$$CaCO_{3(s)} + H_2SO_{4(aq)} \longrightarrow CaSO_{4(aq)} + H_2O_{(l)} + CO_{2(g)}$$

What is the volume of 0.5 M sulphuric acid which is required to react completely with 10 g of calcium carbonate?

(a = 40 , c = 12 , O = 16 , H= 1 , S = 32)

- (a) 100 mL
- (b) 200 mL
- © 300 mL
- (d) 400 mL

What are the probable boiling and freezing points of an aqueous solution of sodium chloride?

Choices	Boiling point	Freezing point
(a)	98°C	−2°C
b	98°C	2°C
0	102°C	−2°C
(d)	102°C	2°C

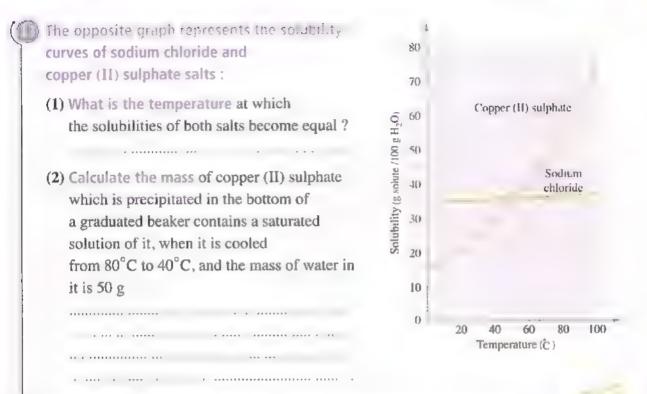
The following table illustrates the colour changes which occur on using 3 chemical indicators:

Indicator	Colour in low pH values	Colour in high pH values	pH range within which the colour changes
Methyl orange	Red	Yellow	3.2:4.4
Bromothymol blue	Yellow	Blue	6:7.6
Phenolphthalein	Colourless	Pink	8.2:10

On mixing 3 equal volumes of the previous indicators, and adding two drops of this mixture to a solution its pH is 6, the colour of the solution will be

- (a) yellow.
- b orange.
- © green.
- (d) blue.

100	
	What is the name of the compound whose chemical formula is MnO ₂ ?
	(d) Manganese (II) oxide. (b) Magnesium (II) oxide.
	(i) Manganese (IV) oxide. (ii) Magnesium (IV) oxide.
	When an acid reacts with an active metal, it produces the gas (X) which is collected by the method (2) that is illustrated in the opposite figure, and when an acid reacts with a carbonate salt, it produces the gas (Y) which is collected by the method (1). Which of the following represents the gases (X) and (Y)? The gas (X) is hydrogen gas which is heavier than air. The gas (Y) is carbon dioxide gas which is lighter than air. The gas (Y) is carbon dioxide gas which is heavier than the gas (X) which is ammonia gas.
,	
	the opposite figure represents one of
	the theories which describe acid and base :
	(1) Write the symbol of (A) and the formula
	of (B) which are represented in this figure. (A) NH ₃ (B)
	(2) Wanch of these two reactants represents the base? Explain
	2 marks
	Filch of calcium carbonate and sodium bicarbonate salts reacts with dilute hydrochloric acid:
	(1) Write the sympolic equation which represents the reaction of each of them with the acid.
	(2) Which of the previous produced solutions has lower freezing point "assuming they have equal molal concentrations"? Explain.



Here are 4 different acidic solutions :









Determine the number of the weak d lute acid, with explaining your answer

Lmark

Calculate the molal concentration which is produced from dissolving 0.0004 mol of iodine in 250 g of dichloromethane.



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The english want should the veletion		
The opposite graph shows the relation	5	
between the ionization percentage of an acid		
and its molar concentration, does this graph	<u>*</u> 1	
represent a strong or a weak acid? Explain.	# 1 # 1	
	інихаі ст регсепіада (%)	
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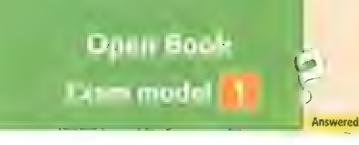
Open Book Exam Models

About the curriculum of the First Term



Answered







Chascille on 1 per ile

Which of the following is not an Arrhenius acid?

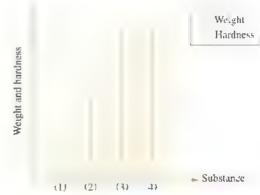
- (a) H,C,O,
- (b) H₂PO₄

O,H,O

(1) HNO,

Which of the substances (1): (4) in the opposite figure represents carbon nanotubes?

- (a) (1)
- (b) (2)
- (c) (3)
- (d) (4)



9 marks

These are 4 molecules of 4 different substances:



Nitrogen molecule



Ammonia molecule



Hydrogen molecule



Water molecule

Which of the following is correct?

Choices	Polar molecule	Nonpolar molecule
	(3)	(1)
(b)	(3)	(2)
0	(2)	(3)
(1)	(1)	(4)

All the following are Brönsted-Lowry bases, except . . .

(a) OH

(b) NH

NH,

(.) H,O



Which of the following represents the weak acid and base?

Choices	Weak acid	Weak base
(1)	H ₂ SO ₄	NaOH
6	HNO ₃	КОН
0	HC1	Ca(OH) ₂
(1)	H ₂ CO ₃	NH ₄ OH



Any organic compound (which is formed of carbon and hydrogen) can be burnt in pure oxygen forming carbon dioxide gas and water vapour.

What is the molecular formula of the organic compound which when burnt yields 1.5 mol of $CO_{2(g)}$ and 2 mol of $H_2O_{(y)}$?

_				
()	~	T	т	
(4)	€.,	Ī	1	

$$\bigcirc C_3H_8$$



You have two equal volumes of sodium hydroxide solution and ammonia solution, both have the same concentration.

Which of the following is true for these two solutions?

0	The electrical conductivity of sodium	hydroxide solution	is less tha	n that of
	ammonia solution.			

- (1) H⁺ ions concentration in sodium hydroxide solution is higher than that in ammonia solution.
- () pH value of sodium hydroxide solution is higher than that of ammonia solution.
- OH" ions concentration in sodium hydroxide solution equals that in ammonia solution.



Which of the following samples has the largest mass?

- a I mol of N₂H₄
- b 2 mol of N₂
- © 3 mol of NH₃
- (1) 25 mol of H,



The mass of one molecule of propanol C3H7OH equals.

(a) 60 g

- (3) 6.02×10^{23} g
- (c) 1×10^{-22} g
- (d) 3.6×10^{25} g





Choose two correct answers:

Which of the underlined items in the following equations represents a Lewis acid?

(a)
$$H_2O + HPO_4^2 \longrightarrow H_2PO_4^- + OH^-$$
 (b) $H^+ + NH_3 \longrightarrow NH_4^+$

$$\bigcirc$$
 H⁺ + NH₃ \longrightarrow NH₄

$$\bigcirc$$
 NO₂ + H₃O⁺ \longrightarrow HNO₂ + H₂O \bigcirc \bigcirc NH₄⁺ + HS⁻ \longrightarrow H₂S + NH₃

$$\textcircled{1}$$
 $NH_A^+ + HS^- \longrightarrow H_2S + NH_3$

$$\bigcirc$$
 NH₃ + BF₃ \longrightarrow NH₃ + BF₃

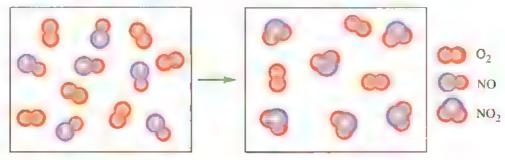


The popular candy shown in the opposite figure is known as cotton candy. is this candy:

- (1) Homogeneous or heterogeneous mixture?
- (2) A solution, a suspension or a colloid?



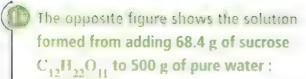
The following figure illustrates the reaction of nitric oxide NO(g) with oxygen O2(g) to form nitrogen dioxide NO_{2(g)}:



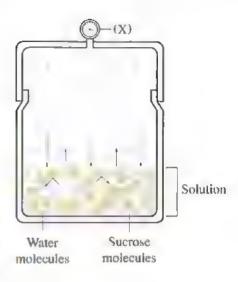
Write the balanced symbolic equation which represents this reaction, and determine the limiting reactant of this reaction.

	u estimate the den			
State the na	ame and the impor	tance of each of the	used tools.	
**********	, , , , , , , , , , , , , , , , , ,	**** 1 (**** ** ***)		
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	4.4 4	* 11 5	*** * 111111	,
equation w Fe	the quantities required then 0.5 mol of $\mathbf{F}_{\mathbf{C}}$		tants and the peaction .	3CO ₂
equation w Fe	the quantities required then 0.5 mol of $\mathbf{F}_{\mathbf{C}}$	ared below the react O_3 undergoes the r	tants and the peaction .	10 8888,0 .6
equation w Fe	the quantities required then 0.5 mol of $\mathbf{F}_{\mathbf{C}}$	red below the react O undergoes the r Og	tants and the peaction .	3CO ₂
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Fe opposite components	he quantities required to the figure shows the ents of a compour	ored below the react O oreginal percentages of	tants and the peaction. 2Fe +	3CO ₂ 3) L 8 36.72%
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The opposition of the componical culate that its mole	te figure shows the molar mass of ecular formula is in the molar mass.	tred below the react O undergoes the r Ogggd this compound, known to the compound of t	tants and the preaction . 2Fe to the control of the preaction atom the preaction atom the preaction atom to the preaction atom the preaction at the pr	3CO ₂ 3) L 8.41% K 44.87%
The opposition of the componical culate that its mole	he quantities required to the control of the compount of a compount of the control of the contro	tred below the react O undergoes the r Ogggd this compound, known to the compound of t	tants and the preaction . 2Fe to the control of the preaction atom the preaction atom the preaction atom to the preaction atom the preaction at the pr	3CO ₂ 3) L 8.41% K 44.87%





- (1) What is the change in the reading of the device (X) which occurs after adding and dissolving sucrose in water?
- (2) Calculate the elevation or the depression of the freezing point which occurs after the complete dissolution of sucrose in water. [C = 12.1] = 1.0 = 16]



2 marks

The appears graph all figure in the solution of three different substances:

- solution of KNO₃ at 70°C

 [K=39.N=14.0=16]
 - (2) Compare the effect of decreasing the temperature on the solubility between the solid substances and the gaseous substances in water.

2 marks





Choose the correct answer for the questions ():







What is the branch of chemistry which is interested in the study of the process of separating a mixture of acetic acid and lactic acid, as well as the estimation of the percentage of each of them in the mixture?

(a) Organic chemistry.

(b) Biochemistry.

() Analytical chemistry.

(1) Environmental chemistry.

Avogadro's number is symbolized by N_A What is the number of the neutrons in 2.3 g of sodium $^{23}_{11}\mathrm{Na}$?

(a) 1.2 N_A

(b) 1.1 N_A

(c) 2.3 N_A

(d) $23 N_A$

Which of the following is not found in the aqueous solution of HCI?

- (a) H⁺
- (b) H₂O
- (c) CI
- (d) HCl

What is the empirical formula of the metal (M) oxide if the mass percentage of oxygen in it is 40%?

 $M = 24 \cdot O = 16$

 $(a) M_2O$

(b) MO

 $(c) M_2 O_2$

 $(d) M_2 O_4$

The reaction of copper (II) oxide with sulphuric acid is represented by the equation:

$$CuO_{(s)} + H_2SO_{4(aq)} \longrightarrow CuSO_{4(aq)} + H_2O_{(l)}$$

What is the ionic equation which represents this reaction?

(i)
$$CuO_{(s)} + 2H_{(aq)}^{+} \longrightarrow Cu_{(aq)}^{2+} + H_2O_{(\ell)}$$

(b)
$$Cu_{(s)}^{2+} + SO_{4(aq)}^{2-}$$
 ← $CuSO_{4(aq)}$

$$\bigcirc O_{(s)}^{2-} + H_2SO_{4(aq)} \longrightarrow H_2O_{(l)} + SO_{4(aq)}^{2-}$$

(d)
$$CuO_{(s)} + H_2SO_{4(aq)} \longrightarrow Cu^{2+} + SO_{4(aq)}^{2-} + H_2O_{(\ell)}$$

2 g of KNO, salt (its molar mass is 101 g/mol) are dissolved in a suitable amount of water to form a solution whose volume = 0.5 L

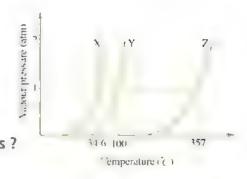
What is the molar concentration of the produced solution?

- (a) 0.02 M
- (b) 0.04 M
- (c) 0,1 M
- (d) 0.2 M





The opposite graphical figure shows
the normal boiling points of three different
substances X,Y and Z which represent water,
diethyl ether (a volatile substance) and
mercury (a liquid metal) in no particular order.
Which of the following represents these substances?



- (d) X represents water and Y represents mercury.
- b Y represents water and Z represents diethyl ether.
- Y represents mercury and Z represents diethyl ether.
- (1) X represents diethyl ether and Z represents mercury.



There are two mixtures (X), (Y):

- Mixture (X): Formed from sand and water.
- Mixture (Y): Formed from salt and water.

Which of the methods illustrated in the following table determines the most proper methods used in separating these components ?

	Mixture (X)		Mixtur	e (Y)
Choices	Obtaining the sand by	Obtaining water by	Obtaining the salt by	Obtaining water by
0	Crystallization	Distillation	Filtration	Filtration
0	Crystallization	Filtration	Filtration	Distillation
()	Filtration	Distillation	Crystallization	Filtration
0	Filtration	Filtration	Crystallization	Distillation



The dyes which are extracted from the following plants can be used in preparing chemical indicators, except

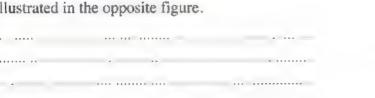
The plant	The original colour of the dye	The colour of the dye in lemon juice	The colour of the dye in sodium bicarbonate solution
a	Purple	Pink	Green
(b)	Green	Yellow	Yellow
0	Pink	Pink	Yellow
(1)	Yellow	red	Green

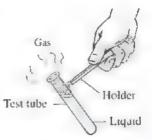
Choose two correct answers:

Which of the following pairs does not represent a conjugate acid and its base respectively?

- (a) NH_4^+ , NH_3 (b) HPO_4^{2-} , PO_4^{3-} (c) H_2O , OH^-
- (1) SO₄², HSO₄ (CI⁻, HCI
- Determine one safety measure

upon performing the experiment which is illustrated in the opposite figure.

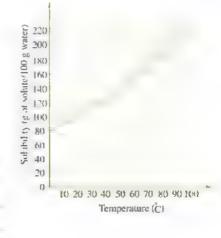




- Arrange the following acids ascendingly according to the number of the types of their salts:
- Phosphoric acid.
- Acetic acid.
- Oxalic acid.

The opposite graph shows the solubility curve of sodium chlorate NaClO3

Calculate the mass of this salt required to be added to its saturated solution at 0°C to remain saturated at 50°C "knowing that the volume of water used as a solvent is 100 mL and its density is 1 g/mL".







Substance	Length	Width	Height
w	17 × 10 ⁻⁸ m	83 × 10 ⁻⁴ m	$96\times10^{-3}~\mathrm{m}$
X	$111.2 \times 10^{-11} \text{ m}$	201 × 10 ⁻¹⁰ m	$3332.2 \times 10^{-12} \text{ m}$
Y	$21\times10^{-10}\;m$	0.18 × 10 ⁻⁵ m	$17.9 \times 10^{-9} \text{ m}$
Z	$130 \times 10^{-7} \text{ m}$	49 × 10 ⁻⁹ m	68 × 10 ⁻⁶ m

State the letter that refers to the substance which is

A three-dimensional nanosubstance.	()

(2) A carbon nanotube.	(.)
------------------------	---	----

	7.1 L of ammonia gas (at STP).	N=14

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		Į
Molar concentra	ation of a solution depends on the temperatu	ure unlike its molal
	ation of a solution depends on the temperate Explain this statement.	ure unlike its molal
		ure unlike its molal
		ure unlike its molal

are the paints of walls classified as colloids not solutions?

l mark

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Exam model 3











Which of the solutions shown in the opposite table has the highest pH?

Soution	Α	8	C	D
H concentration (mol 1)	0.1	0.01	0.001	0.0001

(a) A

(c) C

Which of the following choices describes the aqueous solution of KNO₃ salt?

- (a) Neutral.
- (b) Strong alkaline.
- (c) Weak alkaline.
- (d) Weak acidic.

Which of the following conditions make the dissolving process of 50 g of sugar in 100 g of water the fastest?

Choices	Form of the sugar	Temperature
(1)	Powder	40°C
Ъ	Powder	80°C
0	Cubes	40°C
(1)	Cubes	80°C

1 mol of ethene gas burns according to the equation:

$$C_2H_{4(g)} + 3O_{2(g)} \longrightarrow 2CO_{2(g)} + 2H_2O_{(v)}$$

Ethene Oxygen

What is the number of the moles of the gases and the vapours which are found at the end of the reaction of 1 mol of ethene gas with 4 mol of oxygen gas?

- (a) 2 mol
- (b) 3 mol
- (c) 4 mol
- (d) 5 mol

The reaction of a metal with the acids is represented by the ionic equation:

$$M_{(s)} + 2H_{(aq)}^{+} \longrightarrow M_{(aq)}^{2+} + H_{2(g)}$$

Which of the following metals does not undergo this reaction?

- a) Iron.
- (b) Sodium.
- (c) Magnesium.
- (d) Lead.





- (a) 1×10^6 nm
- © 1×10^{-7} nm

- (b) 1×10^{-6} nm
- \bigcirc 1 × 10⁷ nm

The following table shows the mass percentages of the elements of a compound:

Element	Carbon	Hydrogen	Oxygen
Percentage	26.7%	2.2%	71.1%

What is the empirical formula of this compound?

- a CHO,
- © CHO

- (b) C₂H₂O₄
- (d) C2H2O2

After stirring a sample of copper (II) sulphate in water,

- (a) a solution is formed.
- (b) a suspension is formed.
- (c) a colloid is formed.
- (d) a heterogeneous mixture is formed.

Which of the following substances react with water forming bases each contains two hydroxide ions?

(a) SO₂, CO₂ and NO₂

(b) Li, Na and K

© Mg , Ca and Ba

(d) O, S and Se

(10) Choose two correct answers:

Two samples of oxygen and nitrogen gases have the same volume at the same conditions of pressure and temperature.

What is the similarity between these two gases?

- (a) The number of the molecules.
- (b) The number of the ions.
- (c) The number of the atoms.
- d The molar mass.
- © The number of the moles.

	00 g of ethanol.	[C = 12	, O = 16, H
		** ************************************	44110000000

		**** **	

			2.
111***		,	
The	opposite table shows the molecular formulas of	(A)	C ₂ H ₄
	fferent compounds (A), (B) and (C).	(B)	C ₂ H ₆
	trate without calculations which of these compounds	(C)	C ₃ H ₈ C
its c	mpirical formula has the least molar mass.	(-)	-38
4.4			



•
$$Be_2C + H_2O \longrightarrow BeO + X$$

• $CaC_2 + H_2O \longrightarrow Ca(OH)_2 + Y$

The opposite figure illustrates the process of estimating the concentration of the solution in the tool 2, which has a definite volume by the indication of the known concentration and volume of the solution in the tool (1) (1) What is the difference between the tool (1) and the tool (2)?	$6.02 \times 10^{23} \text{atom}$
the concentration of the solution in the tool 2, which has a definite volume by the indication of the known concentration and volume of the solution in the tool (1) (1) What is the difference between the tool (1) and the tool (2)? 3) What is the name of the process which is illustrated in this illustrated illust	$6.02 \times 10^{23} \text{atom}$
(1) What is the difference between the tool (1) and the tool (2)? (2) What is the name of the process which is illustrated in this (3) What can be concluded from the opposite figure?	$6.02 \times 10^{23} \text{atom}$
(2) What is the name of the process which is illustrated in this What can be concluded from the opposite figure?	$6.02 \times 10^{23} \text{atom}$
and the tool (2)? What is the name of the process which is illustrated in this What can be concluded from the opposite figure?	$6.02 \times 10^{23} \text{atom}$
and the tool (2)? What is the name of the process which is illustrated in this What can be concluded from the opposite figure?	$6.02 \times 10^{23} \text{atom}$
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What can be concluded from the opposite figure ?	$6.02 \times 10^{23} \text{atom}$
What can be concluded from the opposite figure ?	$6.02 \times 10^{23} \text{atom}$
C	A
C	A
C	A
C	A
C	A
C	A
	. /
	03.50
Determine the acid and the base in the reaction which is re	presented by
the following equation:	
C_2H_5	Cl
$C_2H_5 - O - C_2H_5 + AlCl_3 - C_2H_5$	D-Al-CI
C_2H_5	
	Cl
,	

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Choose the correct answer for the questions



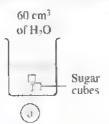


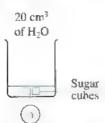


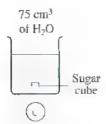
Which of the following equally concentrated solutions has the lowest freezing point?

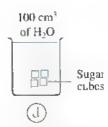
- (a) Potassium sulphate. (b) Sodium chloride. (c) Urea.
- (d) Glucose.

Which of the following sugary solutions is likely to be saturated after the complete dissolution of the sugar cubes in water?





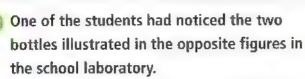




Substance (A) reacts with substance (B) to produce the two substances (X) and (Y) $2A + 3B \longrightarrow X + 2Y$ according to the equation:

What are the amounts of the remaining reactants and those of the products produced from the reaction of 2 mol of (A) with 1 mol of (B)?

Choices	(A)	(B)	(X)	(Y)
a	$\frac{4}{3}$ mol	0	$\frac{1}{3}$ mol	$\frac{2}{3}$ mol
Ъ	$\frac{1}{3}$ mol	$\frac{2}{3}$ mol	0	$\frac{4}{3}$ mol
0	$\frac{1}{6}$ mol	$\frac{4}{3}$ mol	0	$\frac{1}{3}$ mol
(1)	$\frac{2}{3}$ mol	0	$\frac{4}{3}$ mol	$\frac{1}{6}$ mol



What is the correct conclusion which was inferred by this student?

- (a) The two liquids (X) and (Y) are acids.
- (b) The two liquids (X) and (Y) can not be mixed together.
- (c) The liquid (Y) requires heating before use.
- (d) The liquid (X) must not be touched without gloves.





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		d	h



(a) CH₂

(b) C₂H₄

CC3H6

(d) C₄H₈

 ${\bf Pb_3O_4}$ reacts with nitric acid to form lead (II) nitrate, lead (IV) oxide and another product.

Which of the following equations represents this reaction properly?

(b)
$$Pb_3O_4 + 4HNO_3 \longrightarrow Pb(NO_3)_4 + 2PbO + 2H_2O$$

©
$$Pb_3O_4 + 2HNO_3 \longrightarrow 2Pb(NO_3)_2 + PbO_2 + 2H_2O$$

(d)
$$2Pb_3O_4 + 2HNO_3 \longrightarrow 2Pb(NO_3)_2 + 2PbO_2 + H_2$$

A brown powder had been placed in a test tube, and some distilled water was added to it with shaking, after filtration, a black solid substance remained on the filter paper, and after the vaporization of the water of the formed solution (called the filtrate), orange crystals remained.

It is concluded from the previous observations that

- (a) the black solid substance is an element.
- b) the brown powder is a compound.
- c) the brown powder is a mixture.
- (d) the orange crystals are mixtures.

Two drops of each of bromothymol blue and phenolphthalein indicators were added to two samples of two different solutions, pH value of each of them is 2

Which of the following represents the colour formed with each indicator?

Choices	Bromothymol blue	Phenolphthalein
a	Blue	Pink
Ь	Blue	Colourless
©	Yellow	Pink
(1)	Yellow	Colourless

The solution with the lowest pH value is produced from mixing

(a) H₂O with NH₄OH

(b) HNO₂ with KOH

C HCl with Na,CO,

d HNO, with NaOH

10					
1 0	Choose	two	correct	answers	1

All the following about nickel (II) nitrate salt are correct, except that

- (a) it is an ionic compound.
- (b) it dissolves in water.
- (c) it reacts with nitric acid.
- (d) the boiling point of its aqueous solution is higher than 100°C
- e the freezing point of its aqueous solution is higher than 0°C

2 marks

1	18	Calculate	the	molar	mass	of	bucky	ball.
١								

-12

_		
2	Deduce the molecular formula of the hydrocarbon in which the mass percentage of	f

carbon is 82.7% and that of hydrogen is 17.3% C = 12.H =

.....

.....

$$NH_{4(aq)}^{+} + PO_{4(aq)}^{3-} = NH_{3(aq)} + HPO_{4(aq)}^{2-}$$

In the light of your studying for the three theories defining acids and bases.

The following equation represents the concepts of acid and base:

Determine the name(s) of theory(ies)

which explain(s) the acid and the base in this equation.

	_
	1
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The following figures represent the structural configurations of two acids it and (B), one of them is lactic acid and the other is citric acid. In no particular inder"



(B)

- 1 Which of the two figures (A) and (B) represents lactic acid? Give reason for this choice.
 - 2) What is the number of basicity of lactic acid? What is its molecular formula?



Calculate the number of the molecules of lithium oxide which are produced from the thermal decomposition of 37 g of lithium carbonate according to the equation :

 $\text{Li}_2\text{CO}_{3(s)} \xrightarrow{\Delta} \text{Li}_2\text{O}_{(s)} + \text{CO}_{2(g)}$ [1.i=7, C=12, O=16]

Calculate the mass percentage of carbon in methane CH,

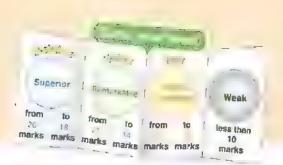
When a little amount of a laundry detergent is added to a trough containing a mixture of hydrochloric acid and magnesium strips, water bubbles are formed with the produced hydrogen gas inside it.

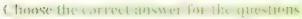
Do these bubbles form a solution or a colloid 2 Exel in

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Exam model 5













All the following are correct regarding the importance of measurement, except

Choices	Importance	Example
	Monitoring	Determination of insulin dose for a diabetic patient.
(1)	Health care	Monitoring glucose in the blood of a diabetic patient.
0	Testing	The composition of a fertilizer.
0	Management	Adding an acidic substance to a highly basic soil.

- What is the number of molecules of oxygen in 466.6 mL sample (at STP)?
 - (a) 1.25×10^{22} molecules.

(b) 1.34×10^{22} molecules.

(c) 3 × 10²² molecules.

- (d) 3×10^{26} molecules.
- 1 mol of ethanol C2H6O is oxidized by potassium permanganate solution which is acidified with sulphuric acid, forming ethanoic acid C,H,O,, the percentage of the actual yield is 60%

What is the mass of ethanoic acid which can be actually collected from the oxidation of 2.3 g of ethanol? [C = 12, H = 1, O = 16]

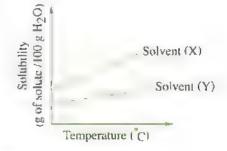
(a) 1.32 g

(b) 1.38 g

(c) 1.8 g

(d) 3 g

The opposite graphical figure shows the effect of changing the temperature on the solubility of the solute (S) in two different solvents (X) and (Y), it is clear from this figure that the solubility of the solute (S)



-) in the two solvents (X) and (Y) is the same.
- in the solvent (X) is generally higher than in the solvent (Y).
- (.) in the solvent (Y) is generally higher than in the solvent (X).
- in the solvent (X) is not affected by raising the temperature.

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	_ (Ď.



On dissolving 7.1 g of Na_2SO_4 (its molar mass = 142 g/mol) in water,

0.5 L of

- (a) 2.5×10^{-2} M solution is produced.
- ⓑ 1×10^{-1} M solution is produced.
- \bigcirc 1 × 10 M solution is produced.
- (d) 1×10^2 M solution is produced.



Which of the following aqueous solutions of the nonvolatile substance (X) has the highest boiling point? A solution that contains

- (a) 1 mol of (X) in 2 kg of water.
- (b) 2 mol of (X) in 1 kg of water.
- © 1.5 mol of (X) in 1.5 kg of water.
- (d) 0.5 mol of (X) in 1 kg of water.



The opposite figure shows a whipped cream in which

- (a) a liquid is dispersed in a liquid.
- (b) a gas is dispersed in a liquid.
- (c) a solid is dispersed in a liquid.
- (d) a liquid is dispersed in a solid.



In the reaction which is represented by the following equation:

$$H_2PO_4^- + H_2O \Longrightarrow H_3PO_4 + OH^-$$

The two Brönsted-Lowry acids in both reaction directions are

(a) H₂O and OH⁻

(b) H₂PO₄ and OH⁻⁻

C H2O and H3PO4

(d) H,PO, and H,PO,



Ammonia $\mathbf{NH_3}$ is a weak base which ionizes in water, according to the equation :

$$NH_{3(g)} + H_2O_{(l)} \longrightarrow NH_{4(aq)}^+ + OH_{(aq)}^-$$

What is (are) the substance(s) which exist(s) in the aqueous solution of ammonia?

- (a) OH only.
- (b) NH, only.
- © NH4 and OH only.
- 1 NH, , H,O , NH, and OH and OH

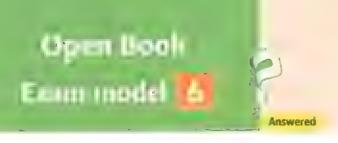
(A): CH_3CH_2COOH (B): CH_3COOCH_3	(c) : HCC	OC ₂ I	\mathbf{H}_{5}	
These compounds are similar in all the following, exce	pt			
d) the mass percentage of carbon and hydrogen in them				
(b) the molar mass.		ients a	atoms	
d) that they are all organic acids.	t with Na	,CO,	form	ing bub
		2 3		
				L
Illustrate how to protect iron from rusting by using the r	nanotechn	ology.		
having the same concentration, which are (in no particular order): • Fructose. • Potassium bromide. • Formic acid. • Potassium carbonate. Choose for each solution the letter which refers to it in the figure. (A): (B):	Electrical conductivity percentage (%) 12% - 10% - 2% 10%	A	B	C D
(D):			JOHL.	IOII
When a cube of sugar was added to an aqueous solution observed that it precipitated in the bottom of the contain (apparently). What is the scientific explanation of this observation	er and did	_		



311.75 g of iron (III) chloride salt.	[Fe = 55.85].

	****** ** ******
	•
The opposite graph represents the masses of	€E.
ron (III) oxide produced from the combination	월 42
of iron with oxygen gas under suitable	20 अधिक क
conditions for the reaction :	E 21
1) Write the balanced symbolic chemical	5
equation which represents this reaction.	ž 1)
	6 10 15 20 25 30
2) What is the substance which remains	Mass of iron (g)
after the end of this reaction ? Explain.	
ator the old of this leadton. Explain.	
	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

Calculate the number of moles of the atoms of th	ne elements found in 44.8 L of
ammonia gas (at STP).	
animonia gas (at 511).	
	•
Allesta the national strong out of the same	execute the reaction of an acid
Write the paranced symbolic equation which rep	
a base to form a salt formed of Ca2+ cations and N	O ₃ anions.





Choose the correct answer for the questions





Each million parts of a river water contains 3 parts of a toxic substance. What is the mass of this substance in 1 kg of the water of this river?

(a) 3 g

- (b) 0.3 g
- © 0.03 g
- (d) 0.003 g

What is the mass percentage of hydrogen in chlorous acid HCIO,?

(a) 1.92%

b) 25%

[H = 1, C] = 35.5, O = 16]

- (c) 23.4%
- d) 1.46%

What is the number of nitrogen atoms in 240 g of ammonium nitrate?

- \bigcirc 2 × 10²³ atoms.
- \bigcirc 6.02 × 10²³ atoms.

What is the total number of moles of H+ found in 2.5 L of phosphoric acid whose concentration is 0.7 M?

- (a) 0,233 mol
- (b) 2.1 mol
- (c) 5.25 mol
- (d) 3 mol

All the following aqueous solutions almost have the same boiling point,

except

- (a) 10 mL of 0.1 M NaCl solution.
- (b) 20 mL of 0.05 M NaCl solution.
- © 20 mL of 0.07 M MgCl, solution.
- (d) 13.33 mL of 0.07 M MgCl, solution.

Which of the following colloids are formed from the dispersion of a liquid in a solid?

- (a) Hair gel, cheese and butter.
- (b) Milk, hair gel and blood.
- (c) Aerosol, hair gel and mayonnaise.
- (d) Mayonnaise, hair gel and cheese.





Each of the following acids when dissolves in water, it can yield more than one proton, except

- (a) oxalic acid.
- (b) sulphuric acid.
- (c) carbonic acid.
- (d) acetic acid.



35.5 mL of an aqueous solution contain 22.5 g of sucrose (its molar mass = 342 g/mol). What is the molarity of this solution?

- (a) 0.0657 M
- ⓑ $1.85 \times 10^{-3} \text{ M}$
- © 1.85 M
- (d) 0.104 M



10 g of hydrogen gas react with excess oxygen gas according to the equation :

$$2H_{2(g)} + O_{2(g)} \longrightarrow 2H_2O_{(v)}$$

What is the reacted volume of oxygen gas (at STP) and the mass of the produced water vapour from this reaction? [H=1,Q=16]

Choices	Reacted volume of O ₂	Mass of H ₂ O
(a)	2.5 L	5 g
b	5 L	5 g
0	56 L	90 g
(d)	80 L	120 g



10 Choose two correct answers:

What happens when a small crystal of the solute substance is placed in its coloured supersaturated solution in a glass beaker?

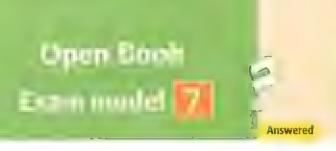
- a The crystal dissolves in the solution.
- (b) The solution becomes saturated.
- © The mass of the beaker increases.
- (d) The solution becomes colourless.
- (e) The mass of the crystal increases by time.

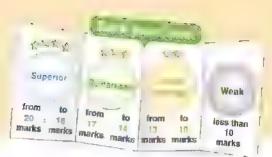
2 marks

	e other torms	in which car	bon can exist.		
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falculate the	molar mass o	of calcium phy	osphate compour	nd	,
Larculate the	motal moss o	n carciam pik	ispirate compoun	Id.	
,					*****
					-
					Ĺ
Complete the	e following eq	juation, then	write the ionic	equation which	represent
	Fe(NO ₂) ₂ ,	+ (NH ₄) ₂ CC)2()	····· +	
	` 3° 2(aq	D + 4-2	3(aq)		
11					

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			n of sodium nitr	ate sait	
	or neutral)? E	жрвані.			
acidic, basic					
acidic, basic	4 * * * * * * * * * * * * * * * * * * *				
acidic, basic				******	
acidic, basic				***	
acidic, basic					
······································	on : NH + H	LO	NH ⁺ , , + OH,		
n this reaction			NH ⁺ _{4(aq)} + OH _(aq)		1
n this reaction			NH ⁺ _{4(aq)} + OH _(aq)		ot of acids
n this reaction					ot of acids
n this reaction	ach of the foll				ot of acids
n this reaction What does eand bases:	ach of the foll				ot of acids

Sulphuric acid is added to barium hydroxide till the completion of the reaction between them.
Write the balanced symbolic ecuality, a
mentioning the physical state of barium hydrox de only in this reaction, then explain
which is larger in number, the ions which are present in the beginning of the reaction or
the ions which are present at the end of the reaction?
2 inark
Color . • the percentage of the actual yield of a product, if its calculated
(theoretical) mass = 0.2716 g and its actual mass = 0.2292 g





	(in software)	and the presti-	on . 🔘 · 🔘 •	9 marks
	Which of the follow	ing expresses the qua	ntitative measuremen	t?
	The burette is lor	ger than the pipette.	HCl is stronger the	han HCN
	Water is a colour	less liquid.	. The boiling point of	of ethyl alcohol is 78,37°C
	What is the number	of moles of hydrogen	sulphide in 49.7 g sar	nple of it ? s 🤫 👪 🕕
	ⓐ 0.686 mol	(b) 1.46 mol	© 83.8 mol	d 24.7 mol
	Which of the follow	ing compounds is a st	rong acid ?	
	(a) H ₂ CO ₃	(b) КОН	© HClO ₄	d HCIO
	16.4 g of HF dissolv	re in water forming a	solution whose volum	e is $2 \times 10^2 \text{mL}$ and
	its concentration is			[H=1,F=19]
	(1) 0.82 M	ⓑ 0.16 M	M 80.0	4.1 M
	What is the type of	the compound which (dissolves in water and	does not
	dissolve in benzene	?		
	Polar only.	Nonpolar only.	O Polar or nonpolar	r. Polar or ionic.
١	The separating funn	el shown in the oppos	ite figure is used to	Q
	separate the compo	nents of the mixture o	of	
	(1) cobalt (II) chlorid	le in water.		

Which of the following choices expres	ses the dimensions of a two-dimensional
nanosubstance ?	

aqueous solution of cobalt (II) chloride in kerosene.

milk.

copper (II) sulphate in water.

Choices	Length	Width	Height
a	1.2×10^{-11} m	200 × 10 ⁻¹⁰ m	$320 \times 10^{-12} \mathrm{m}$
(b)	$21 \times 10^{-10} \text{ m}$	$0.18 \times 10^{-5} \text{ m}$	17.9 × 10 ⁻⁹ m
0	130×10^{-7} m	49×10^{-7} m	$68 \times 10^{-6} \text{ m}$
(J)	$17 \times 10^{-8} \text{ m}$	$83 \times 10^{-4} \mathrm{m}$	$96 \times 10^{-3} \text{ m}$





If the formula of antimony oxide is Sb₂O₃ and that of sodium phosphate is Na₃PO₄, so the formula of antimony phosphate is

- (a) SbPO
- (h) Sb₂PO₄
- (c) Sb₂(PO₄)₃ (d) Sb₃PO₄



20 mL of carbon monoxide gas combust in excess oxygen gas according to the equation:

$$2CO_{(g)} + O_{2(g)} \xrightarrow{\Delta} 2CO_{2(g)}$$

What is the produced volume of carbon dioxide gas (at STP)?

- (a) 20 mL
- (b) 40 mL
- (c) 60 mL
- (d) 80 mL



Choose two correct answers.

The opposite table shows the solubilities of 4 salts (at 20°C). All the following solutions are saturated (at 20°C), except

- (.) 36.5 g of copper (II) chloride in 50 g of distilled water.
- Solubility The salt (g salt / 100 g II,()) Copper (11) chloride 73 Sodium chloride 36 Potassium chloride 34 Ammonium chloride 38
- (1) 36 g of sodium chloride in 100 g of distilled water.
- (c) 17 g of potassium chloride in 50 g of distilled water.
- (1) 18 g of ammonium chloride in 50 g of distilled water.
- () 37 g of copper (II) chloride in 100 g of distilled water.

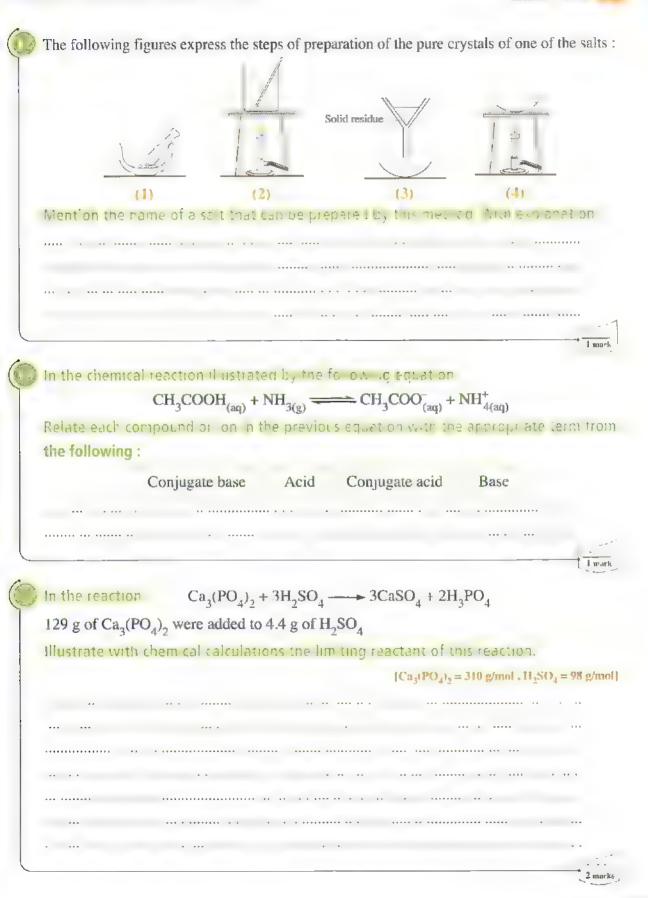


A chemical reaction is expressed by the hypothetical balanced equation:

$$aA + bB \longrightarrow cC + dD$$

What is the number of the possible values of the quantity ? ? With explanation.

I mars

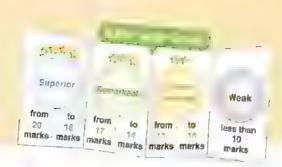


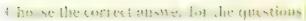
	mL of each of the	colourless hydrochi	loric acid and phe	enolphthalein
indicator.				
		ween the Ly one	mas is with i	17.1 7
* Experiment				
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* Observation	a:			
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		of rhenium chlorid		
given that the	percentage of rhe	nium Re in it is 63.6	5%	1

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	of 9.49 s in n	••••		

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The conjugate base of bicarbonate group is .

a HCO₃

- (b) CO₂
- © CO₃²⁻
- (d) H₂CO₃

Avogadro's number is

- (a) the number of the atoms in one gram of the element.
- (b) the number of the molecules in one gram of the compound.
- the volume which is occupied by one mole of a gas at standard conditions.
- (1) the number of the molecules in the gram molecular mass of the substance.

The volume percentage of nitrogen in atmospheric air is 78% What is the number of moles of nitrogen in 1 L of air (at STP)?

- (a) 0.043 mol
- (b) 0.035 mol
- © 0.78 mol
- (d) 0.87 mol

Ammonia gas reacts with oxygen gas according to the unbalanced equation:

$$NH_{3(g)} + O_{2(g)} \longrightarrow NO_{(g)} + H_2O_{(v)}$$

What is the number of oxygen moles required to react completely with 6.8 g of ammonia gas ? [N = 14 , H = 1]

(a) 0.5 mol

(b) 1 mol

(c) 2.5 mol

(d) 5 mol

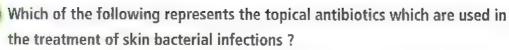
Which of the following acids has the highest pH value?

- (a) 0.1 M HCl
- (b) 0.2 m HCl
- © 0.1 M CH₃COOH
- (1) 0.15 m HNO₃

By comparing the freezing point of 1 m sodium nitrate solution with that of 1 m calcium nitrate solution, the freezing point of .

- (a) both solutions are equal as they are equally concentrated.
- (b) calcium nitrate solution is lower as it contains the higher number of ions.
- sodium nitrate solution is lower as it contains the higher number of ions.
- (1) calcium nitrate solution is lower because its molar mass is larger.





Choices	Gel	Suspension
<u>a</u>	1	1
(b)	1	Х
0	Х	1
(d)	Х	X

1	Which of the following solutions has the highest ability to	conduct electricity
	which of the following solutions has the highest ability the	a congret electricità

- (a) 0.1 M HCl
- (b) 1 M LiOH
- © 2 M H,PO₄
- d 2 M C, H, OH

If the chemical formula of calcium pyrophosphate is ${\rm Ca_2P_2O_7}$, so the chemical formula of iron (III) pyrophosphate is

- (1) Fe₂(P₂O₇)₃
- (b) FeP,O,
- (c) Fe(P,O,),
- \bigoplus Fe₄(P,O₇),

Choose two correct answers:

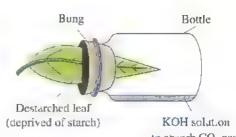
10 nm is equivalent to

- (a) 10⁻⁸ m
- (b) $10^{-7} \, \mu m$
- © 10⁻⁹ mm
- (d) 10 10 m
- © 10⁵ mm



The ophysite figure represents the apparatus used in the experiment of the detection of the effect of CO2 gas in photosynthesis.

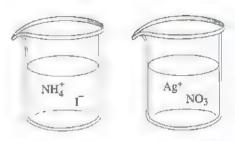
Suggest the science which is likely to be integrated with chemistry in this experiment.



to absorb CO2 gas



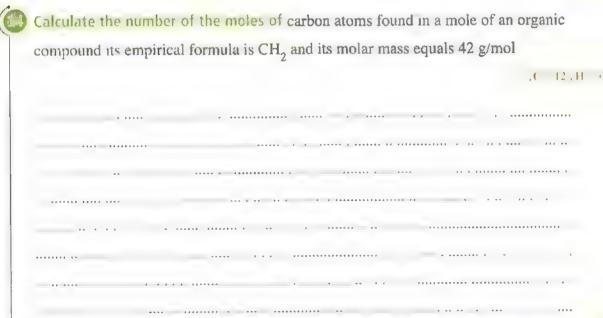
The two opposite figures show two beakers which contain two different aqueous solutions. Write the net ionic equation which represents the reaction between them.





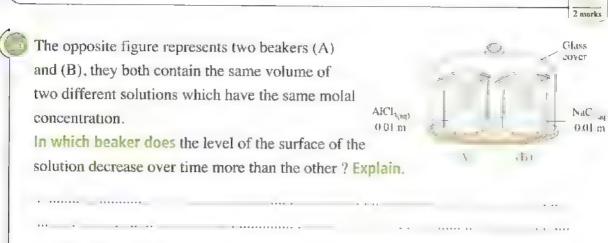
		127 20 71 52 7
its mass $= 27.8 g$		[K = 39, Cr = 52, C]
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2		
Calculate the mo	lar concentration of 250 m	1L of a solution which cor
3.01×10^{23} molec	cules of sodium hydroxide.	
DIOTA TO THOICE	dies of sodium hydroxide.	

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A litmus paper wet with water is approached to the mouth of a test tube that contains a hot mixture of ammonium chloride and sodium hydroxide solutions

What is the change that would occur in the colour of the litmus paper? Explain

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What is the molarity of the solution whose volume is 0.5 L, and contains 0.2 mol of NaOH?

- (a) 0.1 M
- (b) 0.2 M
- © 2.5 M
- (d) 0.4 M

Which of the following formulas represents an empirical formula?

- (a) N₂O₄
- (b) C₂H₂
- (c) NH,
- $(d) P_{\mu} H_{\mu \rho}$

In the reaction represented by the equation : $2H_{2(g)} + O_{2(g)} \longrightarrow 2H_2O_{(v)}$

What is the mass of oxygen gas which reacts completely with 4 g of hydrogen gas?

[O = 16, H = 1]

- (a) 8 g
- (b) 10 g
- (c) 16 g
- (d) 32 g

Compared with pure water, 0.1 M sodium chloride solution has

(a) higher pH

(b) lower boiling point.

(c) higher vapour pressure.

(d) lower freezing point.

What is the mass of 4 atoms of copper?

- (1) $2.37 \times 10^{21} \text{ g}$ (1) $4.22 \times 10^{22} \text{ g}$ (1) $4.22 \times 10^{-22} \text{ g}$

A mixture composed of four different substances is added to benzene, after stirring, a substance (X) is precipitated in the bottom of the container, and separated by filtration, on adding the substance (X) to water with stirring then filtration, then heating the solution which is obtained after filtration (called the filtrate) until complete evaporation of water, a white solid residue of substance (Y) remained. What is the ability of the substance (Y) to dissolve in each of benzene and water?

Choices	Dissolving in benzene	Dissolving in water
(1)	Does not dissolve	Does not dissolve
b	Does not dissolve	Dissolves
0	Dissolves	Does not dissolve
(1)	Dissolves	Dissolves





The following equation is unbalanced:

$$wPCl_5 + xH_2O \longrightarrow yPOCl_3 + zHCl$$

What are the correct coefficients after balancing?

Choices	W	X	y	Z
(8)	1	2	2	4
Ь	2	2	2	2
0	2	2	2	1
(1)	1	1	1	2



Which of the following represents two reactions, both yield an evolving gas which turns clear limewater milky?

Choices	The first reaction	The second reaction
<u>a</u>	Sodium bicarbonate with hydrochloric acid	Sodium sulphate with nitric acid
(b)	Potassium bicarbonate w.tn sulphuric acid	Calcium carbonate with hydrochloric acid
0	Calcium carbonate with sodium hydroxide	Calcium carbonate with nydrochloric acid
(1)	Magnesium carbonate with nitric acid	Calcium sulphite with hydrochloric acid



Sodium hydroxide and ammonium hydroxide are similar in all the following , except that both of them

(a) are bases.

- (b) dissolve in water yielding OH ions.
- © ionize completely in water.
- (d) react with hydrochloric acid.



Choose two correct answers:

In the reaction:

$$C_2H_5COOH_{(aq)} + CN_{(aq)}^- \Longrightarrow CH_3CH_2COO_{(aq)}^- + HCN_{(aq)}$$
Compound (1) Compound (2) Compound (3) Compound (4)

Which of the following statements represents this reaction?

- (a) Compound (1) is H⁺ ion donor, while compound (2) is H⁺ ion acceptor.
- b Compound (2) is H^{\star} ion donor , while compound (1) is H^{\star} ion acceptor.
- Compound (3) is H⁺ ion donor, while compound (4) is H⁺ ion acceptor.
- (a) Compound (4) is H⁺ ion donor, while compound (3) is H⁺ ion acceptor.
- e Both the compounds (1) and (3) are H⁺ ion acceptors.



The following table shows the dimensions of four different substances (A), (B), (C), and (D).

Arrange these substances ascendingly according to their hardness

Stitistance	Length	Vaidth	Height
(A)	1.2×10^{-8} m	$200 \times 10^{-10} \text{ m}$	$322 \times 10^{-10} \text{ m}$
(B)	$21 \times 10^{-10} \text{ m}$	$0.18 \times 10^{-5} \text{ m}$	17.9 × 10 ⁻⁹ m
C1	$130 \times 10^{-7} \text{ m}$	$49 \times 10^{-7} \text{ m}$	68 × 10 ⁻⁶ m
1),	$1.7 \times 10^{-8} \text{ m}$	$83 \times 10^{-4} \text{ m}$	$96 \times 10^{-3} \text{ m}$

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3 g of phosphorus burn in excess of oxygen gas, according to the reaction:

$$P_4 + 3O_2 - P_4O_6$$

So, if the mass of the produced P₄O₆ equals 3.32 g

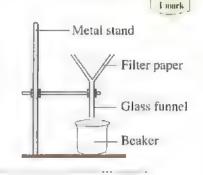
a cuate the percent	og on the actual year.	11'1
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Among the known ions are: NH₄⁺ , Na⁺ , HCOO , NO₃ , Br What is (are) the formula s of the salt's which the pH v. are .) or its (are) solution(s) is (are) lower than 7?



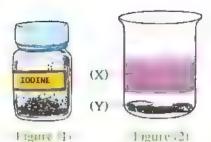
A filtration process was carried out for a liquid mixture using the apparatus shown in the opposite figure, after the end of the process, it was found that the mass of the dried filter paper did not change.

can this result indicate the type of this mixture whether a solution, a suspension or a colloid? Equan





An amount of iodine (figure (1)) was added to a heterogeneous mixture of water with another colourless solvent known as cyclohexane, after stirring, the part (X) of the mixture became violet, while a portion of undissolved iodine remained in the part (Y) of the mixture (figure (2)).



Define the liquid (X), with explanation.



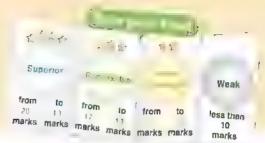
Ascorbic acid is known as vitamin (C), citric acid is found in strawberries and in the berries.

State two other plant sources nich in citric acid and vitamin (C.).



Exam model 10

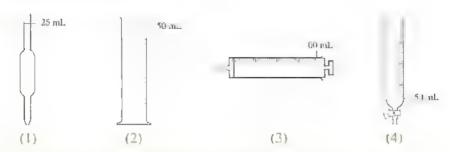




• Choose the com	rectanswer for the qu	Stran 🚺 📗 🕕	9 marks
In bucky ball, w	hat is the number of ca	arbon atoms that eac	h carbon atom is
attached to ?			
(a) 1	(b) 2	© 3	4
Container (A), it	s volume is 0.65 L, coi	ntains 3.35 mol of H	gas, and container (B)
whose volume is	s 1.165 L contains (<i>x</i>)	mol of O_2 gas, both g	gases are exposed to
the same condit	ions of temperature ar	nd pressure.	
What is the valu	e of (x) ?		
(a) 0.226 mol	(b) 1.87 mol	© 6 mol	① 10.15 mol
n which of the f	following aqueous solu	tions – all have the s	ame molal concentration
the depression i	n the freezing point is	the most ?	
⊕ CH ₃ OH	(b) NaF	© MnSO ₄	(1) $(NH_4)_2SO_4$
H ₂ PO ₄ acts as a	n acid in the equation	1111+-	
(1) H ₃ PO ₄ + H ₂ O	$H_3O^+ + H_2P$	O_4^-	
$1 + H_2PO_4^- + H_2O_4^-$	O	02-	
\bigcirc H ₂ PO ₄ ⁻ + OH	$ H_3PO_4 + O^2$	_	
(I) HPO ₄ ² + OH	$I^- \longrightarrow H_2 PO_4^- + O^2$	-	
All the following	g are colloids, except		
air in whippe		air in cotton	candy.
ground maize	e powder in water.	Oxygen in at	mospheric air.
Molal solution c	ontains 1 mol of the se	olute in	
○ 1000 L of the	solvent.	s wile day	Cross Collins
(b) 1000 g of the	solution.		
(c) 1 L of water.			

(d) 22.4 L of the solution.

Here are four different measuring tools:



Which of the following represents the proper use for one of them?

Choices	Measuring tool	Used in
a	(1)	Transferring 20 mL of an alkali to carry out a titration.
(b)	(2)	Collecting 75 mL of the gas produced from a thermal decomposition reaction.
0	(3)	Adding 1 mL of an acid to calcium carbonate.
<u>d</u>	(4)	Adding 15.6 mL of an acid to carry out a titration.

- $igotimes_{f O}$ On dissolving ammonium perchlorate salt ${
 m NH_4CIO}_4$ in water, the formed solution is ...
 - (a) acidic.
- (b) neutral.
- (c) basic.
- (d) amphoteric.
- Nitric acid is a strong acid, because
- (a) it dissolves in water and H⁺ concentration in the solution equals OH concentration.
- (b) it does not ionize in water on dissolving in it.
- it ionizes completely in water into H⁺, NO₃ ions.
- d it is neutralized by a strong base only.

10 Choose two correct answers:

Each of the following is a solution, except

- (a) iron filings with sulphur powder.
- (b) hydrogen chloride gas in water.
- (c) iodine in benzene.
- d silver in mercury.
- (e) powdered milk in water.



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		$\lambda_{\rm H} = 23$, $H = 1$, $C =$
		1 *******
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	**	
The opposite figure represents a section in a flexible		
copper cable, it easily bends with the bends of		
he plastic pipes inside walls and ceilings.		Plastic enver
s it useful to replace copper which is used in the	5	
manufacture of cable wires with any of the following	g? {	
xplain your answer.		Cor
1) Copper nanowires.		
2) Single-walled carbon nanotubes.		

The opposite graph shows the solubility curve	80	
of four different substances A, B, C and D	Ģ, 70 ± 60	
Which of these substances its solubility is:	(O.H. 2001) 20 (O.H.	
1) The highest at 10°C	Solubing inter-min	
2) The lowest at 90°C	10	10.20.25.48.40.20.20
2) The lowest at 90 C		
2) The lowest at 90 C		10 20 30 40 50 60 70 Temperature (8

14	Compare between hydrogen chloride	gas and	glucose by	filling in	n the spaces i	in
	the following table :					

Points of comparison	Hydrogen chloride gas	Glucose
(1) Solubility in water	444444444444	4 + 9 5 5 5 5 5 5 5 5 5 6 5 6 5 6 5 6 5 6 5
(2) Ionization in water	4,	\[\$\delta\times\tim

Magnesium nitrate + Potassium phosphate --- Magnesium phosphate + Potassium nitrate

I mark

Choose with explanation, one or more of the following substances that can be present in a test tube which contains phosphoric acid:

 PO_{Δ}^{3-}

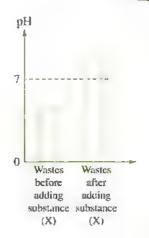
HPO₄

 $H_2PO_4^-$

 H_3PO_4

The opposite graphical figure represents the two pH values of the wastes of a factory before and after adding substance (X).

What is the type of substance (X)? Explain.



Open Book Exam model 11











Nickel-chromium (nichrome) alloy is a

- (a) solution.
- (b) suspension.
- (c) colloid.
- d heterogeneous mixture.

When 25 g of KNO, are dissolved in 200 g of water with stirring, an aqueous solution of potassium nitrate is formed.

What is the method of calculating the mass percentage of this solution?

$$\bigcirc \frac{25}{175} \times 100\%$$

(b)
$$\frac{25}{225} \times 100\%$$

$$\bigcirc \frac{25}{175} \times 100\%$$
 $\bigcirc \frac{25}{225} \times 100\%$ $\bigcirc \frac{25}{200} \times 100\%$ $\bigcirc \frac{220}{225} \times 100\%$

(d)
$$\frac{220}{225} \times 100\%$$

All the following examples are correct for the mentioned mixtures, except

Choices	The mixture	The example
a	Solid in liquid	Coffee
b	Liquid in liquid	Antifreezing solution
0	Gas in liquid	7-up drink
(1)	Solid in solid	Copper

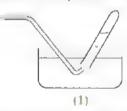
A compound with molecular formula X_4O_6 , each 10 g of it contain 5.72 g of the element X

What is the atomic mass of the element X?

[O = 16]

- (1) 32 amu
- (b) 37 amu
- (c) 42 amu

Dilute hydrochloric acid reacts with calcium carbonate forming gas X which is slightly soluble in water, and has higher density than air.







What is the name of the gas X, and what is (are) the proper method(s) to collect this gas?

- (a) CO, gas / (1), (2) together.
- (b) H, gas / (1), (3) together.

© CO, gas / (2) only.

(d) H₂ gas / (3) only.

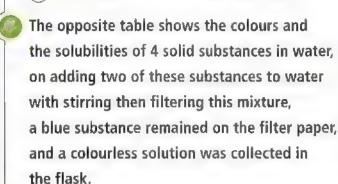


Sulphate salts are prepared by the reaction of dilute sulphuric acid with:

- Active metals.
- Metals oxides.
- Metals carbonates.

What are the substances which can be used in the preparation of copper (II) sulphate salt from dilute sulphuric acid?

- (a) Metal or metal oxide only.
- (b) Metal or metal carbonate only.
- (c) Metal oxide or metal carbonate only.
- (d) Metal, metal oxide or metal carbonate.



Soud substance	Colour	Solubility in water
(1)	White	Soluble
(2)	White	Insoluble
(3)	Blue	Insoluble
(1/2)	Blue	Soluble

What are the used substances?

- \bigcirc (1) and (3).
- \bigcirc (2) and (3).
- () (1) and (4).
- (1) (2) and (4).



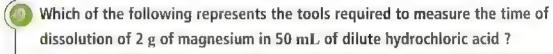
Which of the following equations represents the behaviour of a strong Arrhenius acid ?

(a)
$$CaO_{(s)} + H_2O_{(t)} \longrightarrow Ca(OH)_{2(s)}$$

$$\bigcirc$$
 RbOH_(aq) \longrightarrow Rb⁺_(aq) + OH_(aq)

©
$$Co(OH)_{2(s)} \xrightarrow{Water} Co_{(aq)}^{2+} + 2OH_{(aq)}^{-}$$

(d)
$$HClO_{4(aq)} + H_2O_{(l)} \longrightarrow ClO_{4(aq)}^- + H_3O_{(aq)}^+$$



Choices	Stopwatch	Graduated cylinder	Thermometer	Balance
(1)	1	/	X	X
b	1	X	X	1
0	1	/	×	1
(1)	Х	1	1	1



	1				answers	
í	10	Chanca	distant.	corroct	SPERMORE	
١	A.V	CHOOSE	CAAC	COLLECT	GIIZAAGI 2	

Which of the following represents correct	ly a colourless solution with pH 5 $?$
---	--

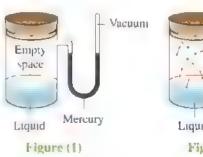
- ... H⁺ ions concentration in it is higher than that of OH⁻ ions.
- (1) H⁺ ions concentration in it is lower than that of OH ions.
- (c) It acquires yellow colour with methyl orange.
- (d) It remains colourless with phenolphthalein.
- H⁺ ions concentration in it is higher than that of OH⁻ ions, and it acquires blue colour with litmus indicator.

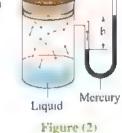
Manufacturing medicines in the form of nanosubstances reduces both their rate of consumption and the side effects.

Explain this statement according to what you have studied

explain this statement according to what you have studied

A vacuum vessel contains an amount of a liquid, and is connected to a U-shaped sealed tube containing an amount of mercury at room temperature and under normal pressure (figure (1)), after some time, the rate of evaporation of the liquid became equal to the rate of its condensation, thus the level of





What does the quantity h represent in figure (2) ?

mercury in the U-shaped tube changed (as in

What is the conjugate acid of HPO_4^2 ion?



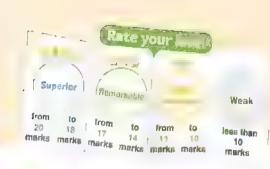
figure (2)).

percentage	or phosp	phorus in it i	S 43.7%				$\{1^2 = 3\}$, O:
						1 1	

	•						•
			* ***	14444444		••	****
	,,,,,						
• •				1 ++++1111	1 1 ** *** *	1 7111 +++1	
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	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,			*****	**********	,,, ,,,,,,,,	1 2
Balance th	e follow	ing equatio	n:				
	KN	dnO → H	so	► K ₂ SO ₄ -	⊾ Mn ∩	ъ Не	n
	1.614	4 11	2004	2504	1711120	7 '2	
							i
	navida	the namehouse	0 ([0] [1 (0) [2 (0)]			DEBILITIES C	
		as combusts					ALLOON GROWI
							Jaroon Git/Ai
gas, accord	ling to th	e equation :	2CO _(g) +	$O_{2(g)} \xrightarrow{\Delta} i$	2CO _{2(g)}		
gas, accord Calculate 1	ling to th	e equation : ne of carbor	2CO _(g) + n dioxide ($O_{2(g)} \xrightarrow{\Delta} G$ gas (at STP) f	2CO _{2(g)}		
gas, accord Calculate 1	ling to th	e equation :	2CO _(g) + n dioxide ($O_{2(g)} \xrightarrow{\Delta} G$ gas (at STP) f	2CO _{2(g)}		
gas, accord Calculate 1	ling to th	e equation : ne of carbor	2CO _(g) + n dioxide ($O_{2(g)} \xrightarrow{\Delta} G$ gas (at STP) f	2CO _{2(g)}		
gas, accord Calculate 1	ling to th	e equation : ne of carbor	2CO _(g) + n dioxide ($O_{2(g)} \xrightarrow{\Delta} G$ gas (at STP) f	2CO _{2(g)}		
gas, accord Calculate 1	ling to th	e equation : ne of carbor	2CO _(g) + n dioxide ($O_{2(g)} \xrightarrow{\Delta} G$ gas (at STP) f	2CO _{2(g)}		
gas, accord Calculate 1	ling to th	e equation : ne of carbor	2CO _(g) + n dioxide ($O_{2(g)} \xrightarrow{\Delta} G$ gas (at STP) f	2CO _{2(g)}		
gas, accord Calculate 1	ling to th	e equation : ne of carbor	2CO _(g) + n dioxide ($O_{2(g)} \xrightarrow{\Delta} G$ gas (at STP) f	2CO _{2(g)}		
gas, accord Calculate 1	ling to th	e equation : ne of carbor	2CO _(g) + n dioxide ($O_{2(g)} \xrightarrow{\Delta} G$ gas (at STP) f	2CO _{2(g)}		
gas, accord Calculate 1	ling to th	e equation : ne of carbor	2CO _(g) + n dioxide ($O_{2(g)} \xrightarrow{\Delta} G$ gas (at STP) f	2CO _{2(g)}		
gas, accord Calculate 1	ling to th	e equation : ne of carbor	2CO _(g) + n dioxide ($O_{2(g)} \xrightarrow{\Delta} G$ gas (at STP) f	2CO _{2(g)}		
gas, accord Calculate 1	ling to th	e equation : ne of carbor	2CO _(g) + n dioxide ($O_{2(g)} \xrightarrow{\Delta} G$ gas (at STP) f	2CO _{2(g)}		
gas, accord Calculate 1	ling to th	e equation : ne of carbor	2CO _(g) + n dioxide ($O_{2(g)} \xrightarrow{\Delta} G$ gas (at STP) f	2CO _{2(g)}		
gas, accord Calculate 1 3.01 × 10 ²	ing to the he volur molecu	e equation: ne of carbon les of carbon	2CO _(g) + n dioxide g	O _{2(g)} $\xrightarrow{\Delta}$ gas (at STP) [le gas.	2CO _{2(g)}		ombustion of
gas, accord Calculate 1 3.01 × 10 ²	ing to the he volur molecu	e equation: ne of carbor les of carbor	2CO _(g) + n dioxide g	$O_{2(g)} \xrightarrow{\Delta} G$ gas (at STP) f	2CO _{2(g)}		ombustion of
gas, accord Calculate 1 3.01 × 10 ²	ing to the volur molecu	e equation : ne of carbon les of carbon	2CO _(g) + n dioxide g n monoxid	O _{2(g)} $\xrightarrow{\Delta}$ gas (at STP) ple gas.	2CO _{2(g)}	rom the c	ombustion of
gas, accord Calculate 1 3.01 × 10 ² There are t solution (A	ing to the he volure molecu	e equation : ne of carbon les of carbon	2CO _(g) + n dioxide go monoxide	O _{2(g)} $\xrightarrow{\Delta}$; gas (at STP) [le gas.	2CO _{2(g)} produced f	rom the c	ombustion of the control of the cont
gas, accord Calculate 1 3.01 × 10 ² There are t solution (A	ing to the he volure molecu	e equation : ne of carbon les of carbon	2CO _(g) + n dioxide go monoxide	O _{2(g)} $\xrightarrow{\Delta}$ gas (at STP) ple gas.	2CO _{2(g)} produced f	rom the c	ombustion of the control of the cont
gas, accord Calculate 1 3.01 × 10 ² There are t solution (A	ing to the he volure molecu	e equation : ne of carbon les of carbon	2CO _(g) + n dioxide go monoxide	O _{2(g)} $\xrightarrow{\Delta}$; gas (at STP) [le gas.	2CO _{2(g)} produced f	rom the c	ombustion of the control of the cont
gas, accord Calculate 1 3.01 × 10 ² There are t solution (A	ing to the he volure molecu	e equation : ne of carbon les of carbon	2CO _(g) + n dioxide go monoxide	O _{2(g)} $\xrightarrow{\Delta}$; gas (at STP) [le gas.	2CO _{2(g)} produced f	rom the c	ombustion of the control of the cont
gas, accord Calculate 1 3.01 × 10 ² There are t solution (A	ing to the he volure molecu	e equation : ne of carbon les of carbon	2CO _(g) + n dioxide go monoxide	O _{2(g)} $\xrightarrow{\Delta}$; gas (at STP) [le gas.	2CO _{2(g)} produced f	rom the c	ombustion of the control of the cont
gas, accord Calculate 1 3.01 × 10 ² There are t solution (A	ing to the he volure molecu	e equation : ne of carbon les of carbon	2CO _(g) + n dioxide go monoxide	O _{2(g)} $\xrightarrow{\Delta}$; gas (at STP) [le gas.	2CO _{2(g)} produced f	rom the c	ombustion of the control of the cont
gas, accord Calculate 1 3.01 × 10 ² There are t solution (A	ing to the he volure molecu	e equation : ne of carbon les of carbon	2CO _(g) + n dioxide go monoxide	O _{2(g)} $\xrightarrow{\Delta}$; gas (at STP) [le gas.	2CO _{2(g)} produced f	rom the c	ombustion of the control of the cont

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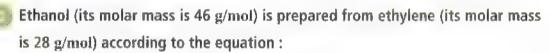
(hoose:	the corr	ect answe	r for the c	urestions
,	FILLER	CALL CALL	C.C. C. COLLEGE CO. C.	1 1 1 1 1 1 1 1	Acres . Pressure



ij	omrks



- (a) an ionic compound,
- (b) a covalent compound.
- © a homogeneous mixture.
- d a heterogeneous mixture.



$$C_2H_4 + H_2O \longrightarrow C_2H_5OH$$

Ethylene

Ethanol

So, if you know that 28 g of ethylene yield 43.7 g of ethanol.

What is the percentage of the actual yield?

(a) 64%

(b) 84%

© 95%

d) 156%



(a) HBr

(b) NaOH

© NaBr

(d) NH,

Butane C_4H_{10} burns according to the reaction :

$$2C_4H_{10(g)} + 13O_{2(g)} \longrightarrow 8CO_{2(g)} + 10H_2O_{(v)}$$

Which of the following represents the correct ratio between oxygen and butane gases as reactants?

(a) $\frac{13 \text{ g O}_2}{2 \text{ g C}_4 \text{H}_{10}}$

(b) 13 mol O₂ 2 mol C₄H₁₀

© $\frac{26 \text{ g O}_2}{14 \text{ g C}_4 \text{H}_{10}}$

- What is the compound which dissolves in water forming a solution that has a relative ability to conduct electricity?
 - (a) C₂H₅OH (b) C₆H₁₂O₆
- © C₁₂H₂,O₁₁
- (d) CH₂COOH

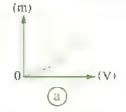
The apparatus which is illustrated in the opposite figure is used in the simple distillation of table salt solution, where is each of the salt and water collected at the end of the experiment?

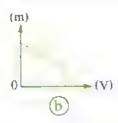
Hou	water	
n	at .	
Heat	Cold water	5 5
1	in	\Box

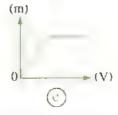
Choices	Salt	Water
a	Volumetric flask	Glass beaker
Ъ	Conical flask	Glass beaker
0	Glass beaker	Round bottom flask
(b)	Round-bottom flask	Glass beaker

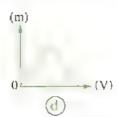
- On adding excess of potassium iodide KI solution gradually to mercury (II) chloride solution HgCl2, these two reactions occur:
 - $HgCl_{2(aq)} + 2KI_{(aq)} \longrightarrow HgI_{2(s)} + 2KCl_{(aq)}$
 - $HgI_{2(s)} + 2KI_{(an)} \longrightarrow K_2HgI_{4(an)}$

Which of the following graphical figures represents the relation between the mass of the formed precipitate (m) and the added volume of KI solution (V)?





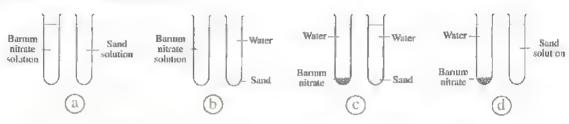




- A mole of potassium nitrite is similar to a mole of potassium nitrate in all the following, except
 - (a) number of moles of O atoms.
 - (b) number of moles of K atoms.
 - (c) number of moles of N atoms.
 - (d) number of moles of the ions in the aqueous solution.



What is expected to happen when each of barium nitrate and sand is stirred, each individually, in water ?



10 Choose two correct answers :

Which of the following represents sulphuric acid?

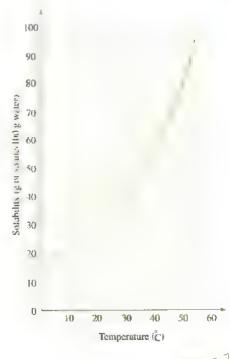
- (a) I mol of sulphuric acid ionizes in water yielding 2 mol of ions.
- (b) 1 mol of sulphuric acid reacts with 2 mol of sodium hydroxide.
- © Sulphuric acid forms only acidic salts.
- d Sulphuric acid forms two types of salts.
- (e) Sulphuric acid reacts with divalent metals only.

Carculate the	gram mass o	of a sample of carbon [C=12] which contain	is quarter of
Avogadro's nu	mber of aton	ns.		

			,	

********	******		*** ***** * ***	***********
,.	*** ******** * 11			
		***************************************		,
		P P7777 HARMANNI (5++		
			* **********	** ** ****

the solubility curve of	f potassium nitrate salt KI	NO.
Illustrate with the ch		3
the molality of a satu	rated solution of KNO ₃	
(at 40°C).	[K = 39, N = 14, O =	16
140000001111100000000		
	*** ** ******** * * **	



18	Illustrate with explanation the type of a m	ixture formed	of partic	es with	
	diameter equals 1.9×10^{-8} m				
					.,,,
			,		

In the light of the interest of the scientists in reducing the consumption of the aviation fuel, there are attempts being made to replace the copper conductors with plastic conductors known as polyaniline.

What is the substance which is added to polyaniline to render it a better electric conductor than copper?

.....

1 mark

2 marks

- 4	-	
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4	7	
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		7.7 F		•
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_				
contains 1 g of	nydrogen.	cal formula is CHO_2 and CHO_3 and CHO_3 and CHO_3 are specified this compound.	and each 0.5 mol of it	
contains 1 g of	nydrogen.		and each 0.5 mol of it	,,,,,,,,
contains 1 g of	nydrogen.		and each 0.5 mol of it	,,,,,,,,
contains 1 g of	nydrogen.		and each 0.5 mol of it	
contains 1 g of	nydrogen.		and each 0.5 mol of it	,,,,,,
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contains 1 g of	nydrogen.		and each 0.5 mol of it	
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Contains 1 g of Deduce the mo	nydrogen.	of this compound	· · · · · · · · · · · · · · · · · · ·	
Contains 1 g of Deduce the mo	nydrogen.	of this compound.		
Contains 1 g of Deduce the mo	hydrogen. lecular formula c	of this compound.		

			-
_	Exam	Model	1

	_	
1	60	
		78
1	400	

Malonic acid is used in synthesis of vitamins B, and B2:

HOOC - CH₂ - COOH

(1) Calculate the mass percentage of oxygen in malonic acid.

......

(2) Mention a similarity and a difference between malonic acid and citric acid.

2 marks

Open Boolt Exam model 13

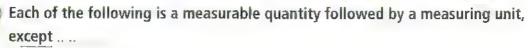




Choose the correct answer for the questions (







- (a) pH value of a solution.
- (b) the molality of a solution.
- the nanovolume of solid particles.
- d the molar mass of a gas.

All the chemical formulas of the compounds shown in the following table are correct, except

Choices	The compound	The chemical formula
a	Aluminum oxide	Al ₂ O ₃
(b)	Calcium nitrite	Ca(NO ₂) ₂
0	Iron (II) bromide	Fe ₂ Br
(I)	Potassium sulphite	K ₂ SO ₃

An element (X) its gram atomic mass is 16 g/mol and its electronic configuration is (2, 6), another element (Y) its gram atomic mass is 19 g/mol and its electronic configuration is (2, 7).

What is the gram molecular mass of the compound which results from the combination of the atoms of the two elements (X) and (Y)?

- (a) 54 g/mol
- (b) 60 g/mol
- © 70 g/mol
- d 103 g/mol

Which of the following represents a pair of conjugate acid and base?

- (a) H₃PO₄ and PO³₄
- \bigcirc $H_2PO_4^-$ and PO_4^{3-}
- © H₃PO₄ and HPO₄²⁻
- (d) H,PO4 and HPO4-



In which of the following molecular formulas is the mass percentage of hydrogen the smallest?

[C = 12, H = 1, O = 16]

(a) CH,O,

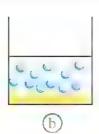
(b) C₃H₆O

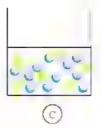
C,H,O

(d) CH,O

Which of the following diagrams expresses a mixture of oil and water?









Oil particles Water molecules

All the following factors affect the solubility of the substances, except

(a) the temperature.

(b) the speed of the stirring.

(c) the type of the solvent.

(d) the type of the solute.

In the reaction:

$$C_6H_5OH + 3Cl_2 \longrightarrow C_6H_2Cl_3OH + 3HCl$$

Compound (A) Compound (B)

When 50 g of the compound (A) react with excess chlorine gas, 97.6 g of the compound (B) are formed.

What is the percentage of the actual yield?

C B H i + 1 + 1 + 35.5

(a) 92.9%

(b) 51.2%

(c) 49.4%

(d) 47.6%

What is the net ionic equation which represents the formation of barium carbonate salt, which is produced from the reaction of barium chloride solution with sodium carbonate solution?

(a)
$$Ba_{(aq)}^{2+} + CO_{3(aq)}^{2-} \longrightarrow BaCO_{3(aq)}$$

(b)
$$Na_2CO_{3(aq)} + BaCl_{2(aq)} \longrightarrow 2Na_{(aq)}^+ + 2Cl_{(aq)}^+ + BaCO_{3(s)}$$

©
$$Ba_{(aq)}^{2+} + CO_{3(aq)}^{2-} \longrightarrow BaCO_{3(s)}$$

(d)
$$Na_2CO_{3(aq)} + BaCl_{2(aq)} \longrightarrow 2NaCl_{(aq)} + Ba_{(s)}^{2+} + CO_{3(s)}^{2-}$$

Choose tv	vo correct answers :	
Which of	the following is correct ?	
The ac	jueous solution of magnesium oxide its pH is little less than 7	
The ac	acous solution of sulphur trioxide its pH is much greater than 7	
The ac	queous solution of ammonium formate its pH is almost 7	
d Calciu	m oxide reacts with nitric acid forming salt and water.	
C Carbo	n dioxide reacts with hydrochloric acid forming salt.	
can be see	on by the naked eye?	
can be see	n by the naked eye?	
can be see	n by the naked eye?	
can be see	n by the naked eye?	
can be see	n by the naked eye?	
	· · · · · · · · · · · · · · · · · · ·	
 Calculate	the molality of the solution produced from adding 0.25 mol of	
 Calculate	· · · · · · · · · · · · · · · · · · ·	
 Calculate	the molality of the solution produced from adding 0.25 mol of	
 Calculate	the molality of the solution produced from adding 0.25 mol of	
 Calculate	the molality of the solution produced from adding 0.25 mol of	

hydrochloric acid, 1 mol of sodium carbonate or 1 mol of sodium bicarbonate.

1 mark

of water an	d benzene ? Wit	h explanation.		
(1) Oil,				
T) OII.				
	P T I	* * ***********************************		
	***** **		* ******	
2) Potassiu	m hydroxide.			
	,			
				**** **
	** ** *		**********	,
Calculate th	ne mass of 37.8 L	of methane gas (at S	TP).	(= 12, }
	4++++ +7111+++	,,,, ;,, ,,,,, ,,,,,, ,,,,,,,,,,,,,,,,		****

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		th nitrogen [N=14] for les of element (X) w		2
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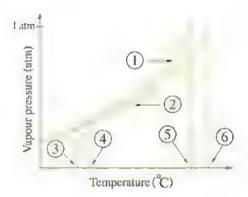




The opposite graphical figure represents

the relation between the vapour pressure of each of (pure water and an aqueous solution) and the temperature.

Write beside each term of the following the appropriate number which refers to it (in the graph):



(1)	., ,	Freezing point of solution	.,.,.,	Vapour pressure of solution	*****	Boiling point of solution
(2)		Freezing point of pure water		Vapour pressure of pure water		Boiling point of pure water

Which is greater:

The difference between the boiling points of pure water and the solution or the difference between the freezing points of pure water and the solution?

Open Sout

Exam model 14













The screen of the mobile phone is covered with a nanoliquid to form a thin layer on its surface to protect it from scratching and breaking.

What is the type of the material used in manufacturing this nanoliquid?

(a) Colloidal substance.

(b) One-dimensional nanosubstance.

(c) Suspended substance.

(d) Two-dimensional nanosubstance.

Which of the following equations represents the dissolving process of cesium bromide salt in water?

$$\bigcirc$$
 CsBr_(s) $\xrightarrow{\text{water}}$ Cs⁺_(s) + Br⁻_(s)

The ionic equation which represents the reaction of sodium hydroxide solution with hydrochloric acid does not include each of

In the reaction:

$$6\text{Li}_{(s)} + \text{N}_{2(g)} \longrightarrow 2\text{Li}_3\text{N}_{(s)}$$

What is the number of moles of lithium required to react with excess of nitrogen gas to produce 0.6 mol of lithium nitride?

- (a) 0.2 mol
- (b) 0.3 mol
- © 0.4 mol
- (d) 1.8 mol

Each of the following is among the properties of lactic acid, except that it

(a) is found in yogurt.

(b) is an organic acid.

() is a weak acid.

(d) reacts with sodium to form salt and water.

These compounds formulas: KNO_3 , $Pb(NO_3)_2$, $Fe(NO_3)_3$ indicate that the nitrate group is

(a) monovalent only.

(b) divalent only.

(c) trivalent only.

(d) mono, di, and trivalent.





There are 3 samples of different gases at the same conditions of temperature and pressure :

- (1) 4 g of argon gas.
- (2) 3.2 g of oxygen gas.
- (3) 4.4 g of carbon dioxide gas.

What is the correct relation between the volumes of these samples of the gases?

(a) Volume of sample (1) > Volume of sample (2).

 $\{Ar = 40, O = 16, C = 12\}$

- (b) Volume of sample (2) > Volume of sample (3).
- © Volume of sample (1) = Volume of sample (3).
- d Volume of sample (3) > Volume of sample (1).

(B)

In the opposite table :

The boiling point of water which contains a little amount of acetone is

Substance	Boiling point
Acetone	56°C
Water	100°C

(a) 56°C

(b) 78°C

(c) 100°C

(d) 104°C



- Which of the following represents the aqueous solution of each of glucose (its molar mass = 180 g/mol), and the table salt (its molar mass = 58.5 g/mol)?
- (a) Both are liquid in solid solutions.
- (b) Both are electrolytes.
- Freezing point of the salt solution is lower than that of glucose solution at equal concentrations.
- (1) When each of them contains a mass (X) of the solute in the same volume of water, the concentration of glucose solution is higher than that of the salt solution.

(10

Choose two correct answers:

The reaction of acetic acid with sodium hydroxide solution yields a(an)

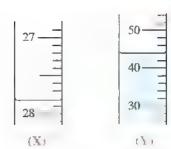
- alkaline solution.
- (b) acidic solution.
- (c) neutral solution.
- d gaseous solution.
- (e) salty solution.

2 mnrks



The opposite figures (X) and (Y) represent two sections in two measuring tools:

- Tool (X): Is used in measuring a definite volume of an acid accurately.
- Tool (Y): Is used in estimating the increase in the volume of water on dipping a piece of iron in it.



What is the name of each tool?

What is the volume of the measured liquid in each of them?

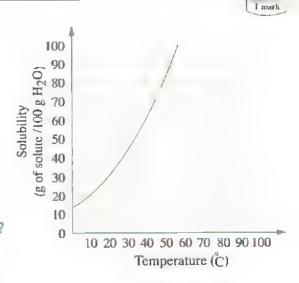
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According to the opposite figure which represents the solubility curve of potassium nitrate in water, on stirring 75 g of potassium nitrate in 100 g of water at 100°C, no precipitate is formed and when the solution is cooled to 30°C, a precipitate appears.

What is the type of this solution

(unsaturated / saturated / supersaturated)?
Explain your answer, and calculate
the precipitated mass of potassium nitrate
after cooling to 30°C approximately.



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	s percentage of carbon in oxalic acid	1. $ C = 12 O = 16$

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	Experiment	
when is compose	d of substance (X) and water : Experiment	Observation
1 On stirring the I	nivhire well	Substance (X) does no
(1) On surring the i	mature well	dissolve in water
	nixture for some minutes after shaking	dissolve in water Substance (X) does no precipitate in water
② On leaving the		Substance (X) does no precipitate in water
② On leaving the r ③ On pouring the	mixture for some minutes after shaking mixture in a funnel containing a filter pape	Substance (X) does no precipitate in water Substance (X) is not sepa from water
② On leaving the r ③ On pouring the	mixture for some minutes after shaking	Substance (X) does no precipitate in water Substance (X) is not sepa from water
2) On leaving the r 3) On pouring the	mixture for some minutes after shaking mixture in a funnel containing a filter pape	Substance (X) does no precipitate in water Substance (X) is not sepa from water
2) On leaving the r 3) On pouring the	mixture for some minutes after shaking mixture in a funnel containing a filter pape	Substance (X) does no precipitate in water Substance (X) is not sepa from water
2) On leaving the r 3) On pouring the	mixture for some minutes after shaking mixture in a funnel containing a filter pape	Substance (X) does no precipitate in water Substance (X) is not sepa from water
2) On leaving the r 3) On pouring the	mixture for some minutes after shaking mixture in a funnel containing a filter pape	Substance (X) does no precipitate in water Substance (X) is not sepa from water
2) On leaving the r 3) On pouring the Depending on the Is it a solution?	mixture for some minutes after shaking mixture in a funnel containing a filter pape	Substance (X) does no precipitate in water Substance (X) is not sepa from water
2) On leaving the r 3) On pouring the Depending on the Is it a solution?	mixture for some minutes after shaking mixture in a funnel containing a filter pape	Substance (X) does no precipitate in water Substance (X) is not sepa from water
2) On leaving the r 3) On pouring the Depending on the Is it a solution?	mixture for some minutes after shaking mixture in a funnel containing a filter pape se observations, recognize the type	Substance (X) does no precipitate in water Substance (X) is not sepa from water

one drops of meary orange mate	ator by adding the acid to it?
	, , , , , , ,
***************************************	***************************************

Among the well known chemical	
Magnesium hydroxide.	 Magnesium oxide.
2) Why is magnesium hydroxide of	lescribed as a base and not an alkali, while
magnesium oxide is described:	
	as a base and an alkali ?
magnesium oxide is described	as a base and an alkali ?
magnesium oxide is described	as a base and an alkali?
magnesium oxide is described:	as a base and an alkali?
magnesium oxide is described:	n of a solution of table salt its volume = 1.5 L
magnesium oxide is described:	n of a solution of table salt its volume = 1.5 L
Calculate the molar concentration and contains 26.325 g of sodium contains 26.325 g of	n of a solution of table salt its volume = 1.5 L













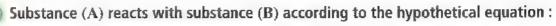
Which of the following prefixes does not represent its true value?

(a) Micro = 10^{-6} of the unit.

(b) Kilo = 1000 units.

© Deci = 10 units.

d Nano = 10^{-9} of the unit.



$$3A + B \longrightarrow C + D$$

What is the limiting reactant of the reaction of 2 mol of (A) with 1 mol of (B)?

- (a) (A) / As its molar mass is the smallest.
- (b) (A) / As all its moles are consumed in producing the least number of products moles.
- (B) / As the number of its moles is less than the number of moles of (A).
- (d) (B) / As 3 molecules of (A) react with 1 molecule of (B).

A sample of nitrogen gas its mass is 28 g contains



- (a) 6.02×10^{23} nitrogen atoms.
- \bigcirc 1.204 × 10²⁴ nitrogen molecules.
- the same number of nitrogen atoms found in 17 g of ammonia.
- () the same number of nitrogen atoms found in 34 g of ammonia.

Why is glucose soluble in water, while benzene is not, even though they both are organic compounds?

- (a) Due to the difference of their molar masses.
- (b) Because glucose is an ionic compound, while benzene is a covalent compound.
- Because glucose is a strong electrolyte, while benzene is a weak electrolyte.
- Because glucose contains polar (O − H) bonds, while benzene contains C, H only.

Which of the following represents the expected boiling and freezing points of an aqueous solution of sodium chloride respectively?

(a) 98°C , 1.6°C

(b) 100°C , 0°C

@ 102°C , -1.6°C

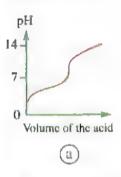
(d) 102°C , 0°C

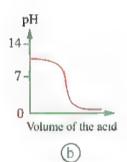
One of the most famous sauces is prepared by whipping egg yolks, and during continuous whipping, oil is added drop by drop, then afterwards drops of vinegar are added.

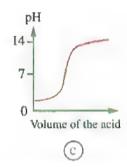
What is the classification of the mixture which composes this sauce?

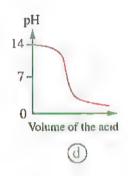
- (a) Colloid (liquid in liquid).
- (b) Colloid (liquid in solid).
- © Suspension (solid in liquid).
- (d) Solution (gas in liquid).











Which of the following tools would be used in a titration process? And what is the missing tool?









Choices	Used tool	Missing tool
(a)	(1),(2)	Glass beaker
b	(2),(3)	Sensitive balance
0	(1),(4)	Round - bottom flask
<u>d</u>	(2),(4)	Conical flask

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(Which of the following equations represents correctly the reaction of sodium				
	carbonate solution with sulphuric acid ?				
	(a) $Na_2CO_{3(s)} + H_2SO_{4(aq)} \longrightarrow Na_2SO_{4(s)} + H_2O_{(\ell)} + CO_{2(g)}$				
1	(b) $CO_{3(aq)}^{2-} + 2H_{(aq)}^{*} \longrightarrow H_2O_{(l)} + CO_{2(g)}$				
	\bigcirc Na _(s) ⁺ + CO _{3(s)} ²⁻ + H ₂ SO _{4(aq)} \longrightarrow Na ₂ SO _{4(aq)} + H ₂ O _(t) + CO _{2(g)}				
	(d) $CO_{3(s)}^{2-} + 2H_{(aq)}^{+} \longrightarrow H_2O_{(aq)} + CO_{2(g)}$				
	Choose two correct answers :				
	Which of the following pairs of substances when mixed together, they form				
	a solution its pH is higher than 7 and lower than 13?				
	Two equal volumes of hydrochloric acid and sodium hydroxide solution both have the same concentration.				
	(b) Ammonia solution and water. (c) Magnesium with excess nitric acid.				
	d Sodium hydroxide and water. Baking soda and water.				
	2 marks				
11	"Science fiction is becoming by time and efforts touchable facts".				
	Clarify the previous statement in the light of astronomers' expectations regarding the use of carbon nanotubes.				
	, , , , , , , , , , , , , , , , , , , ,				
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	Calculate the molality of the solution produced from dissolving 2.7 g of CH ₃ OH in				
	25 g of H_2O { $C = 12, H = 1, O = 16$ }				



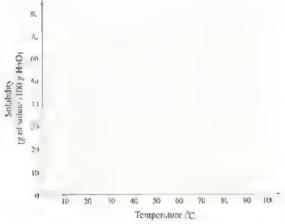
Solid scandium element reacts with chlorine to form ScCl₃

What is the value of the coefficient of $ScCl_{\chi}$ in the balanced chemical equation of the reaction ?

The following table shows the solubility of copper (II) sulphate in water at different temperatures:

Temperature (°C)	0	20	40	60	80	100
Solubility (g of solute/100 g H2O)	14	20	28	40	56	77

(1) Use the values shown in the previous table to draw the solubility curve of copper (II) sulphate.

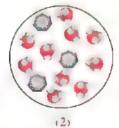


(2) What is the maximum mass of copper (II) sulphate that can be dissolved in 100 g of water at 50°C?



The following figures represent the aqueous solutions of three different compounds:







Choose from the following compounds what matches each of the previous figures:

- Sodium chloride.
- (.....)
- (2) Potassium phosphate. (.....)

- (3) Glucose.
- (.....)







Complete the following equation: $H_2SO_{4(aq)} + H_2O_{(l)}$ Why is water classified in this process as a base?





4 balloons are inflated with four different gases at the same conditions of temperature and pressure, their masses are:

• First balloon: 4.4 g of CO, gas.

· Second balloon: 9 g of NO gas.

• Third balloon: 9.2 g of NO2 gas.

• Fourth balloon: 11.2 g of CO gas.

Arrange these balloons ascendingly according to their volumes, and explain your answer with chemical calculations. [C = 12, N = 14, O = 16]

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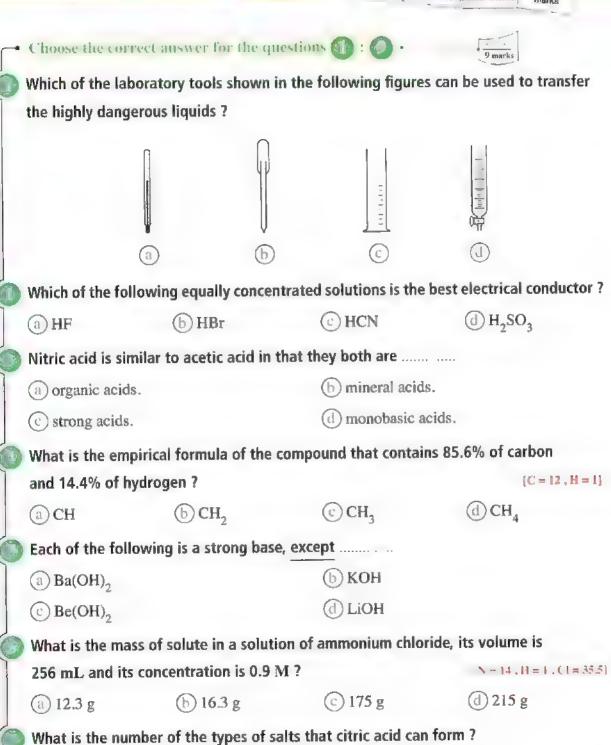
Open Book Exam model <mark>1</mark>4

(a) I

(b) 2







(c)3



 $ig(oldsymbol{8} ig)$ In the following equation :

$$C_6H_5NH_{2(aq)} + H_2O_{(f)} - C_6H_5NH_{3(aq)}^+ + OH_{(aq)}^-$$

Reactants and products can be classified as follows: . _____

- (a) Acid + Base Acid + Base
- (b) Acid + Base Base + Acid
- (c) Base + Acid Acid + Base
- (d) Base + Acid Base + Acid

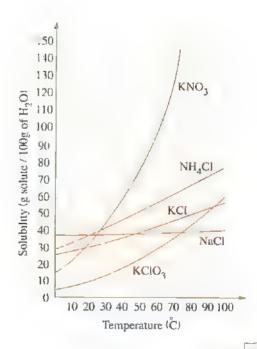
What is the pair of the equally concentrated solutions which represents a weak base and a strong acid respectively?

- (a) NH₄Cl , HCl
- D NH, , HCI
- ONH, , NaOH
- (d) NaOH, HC1

Choose two correct answers:

From the opposite solubility curve: Which of the following substances that are dissolved in 100 g of water (at 40°C) forms a saturated solution?

- a 20 g of KClO,
- (b) 25 g of NaCl
- © 30 g of K.Cl
- (1) 40 g of NH₄Cl
- @ 70 g of KNO,



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Complete the fo			hat is suitable fro	\ / - \	rances:
		Gas	Liquid	Solid	
	Nickel c	hrome alloy	Atmospheric air	Sea water	
Types of solu	ution	Physical stat	e of solute Physic	ai state of solvent	Exampl
(1) Gaseous solu	tion	,,, ,,, ,,,,			.,
(2) Liquid solution	on	*********	4444	4444841914994494444444	********
(3) Solid solution	n	***********			********
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The two opposit	te figure	es represent			
the structures of	phospho	orus and			
sulphur vapours	_				1
If you know that	the gra	m atomic mass		The state of	T
of phosphorus is	31 g/m	ol	J.		
	ur is 32	g/mol:		(X)	(Y)
and that of sulph			re of phosphorus v	apour molecule?	
	represe	nts the structu			
	represe	nts the structu	. ,,		
(I) Which figure			apour of each of th	ne two elements.	
(I) Which figure			apour of each of th	ne two elements.	

its mass is 500 g as	na ite concentration ie	en ent	solut
	nd its concentration is	1.3%	
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,, , ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		,, (,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	14111111
		******	111515477
In the light of your	knowledge about the	relation between the vapour pressur	re and
each of the boiling	and freezing points of	feach of pure water and the solution	1,
replace the numb	ers shown on the follo	owing figures with what suits each	ı of tl
from the next two	terms:		
• Pure water.		• The solution.	
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(atrn)		E 760	
ba ba		5 (3)/h	
UNS !	(1)		
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Vapour pressure (atm)	2	A mum 3 (3)	
	-1.86 0	100100.5	
	-1.86 0 Temperature (C)	1 2	
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Na ⁺ NH ⁺ ₄	$Cl^ CO_3^{2-}$
Conclude the chemical formula of the salt t	hat dissolves in water forming :
(1) A solution its pH equals 7	()
(2) A solution its pH is less than 7	()
(3) A solution its pH is more than 7	()

its mola	ar mass is 146 g/mo			[]H
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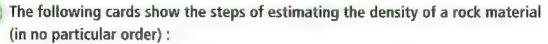




Choose the correct answer for the questions in a

















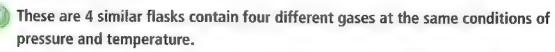


What is the correct order of the steps of estimating the density of the rock material?

(3)

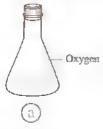
$$\bigcirc (4) \rightarrow (2) \rightarrow (1) \rightarrow (5) \rightarrow (3).$$

$$\bigcirc (1) \rightarrow (3) \rightarrow (4) \rightarrow (2) \rightarrow (5).$$



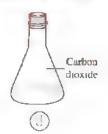
Which of these flasks has the largest mass?











Which of the following ions can not behave as a base and as an acid in different reactions?

- \bigcirc HPO $_4^{2-}$
- (b) SO₃²⁻
- (C) HC₂O₄
- d HSO₄

What is the anion that exists in the highest concentration in the solution which is produced from the reaction of 0.1 mol of ${\rm H_3AsO_4}$ acid with 0.1 mol of sodium hydroxide ?

- (a) HAsO₄²⁻
- (b) OH-
- © H₂AsO₄
- d Na+



Which of the following sodium sulphate crystalline salts loses 56% of its mass after the complete evaporation of all water found in it?

(a) Na,SO,H,O

(b) Na,SO,.2H,O

© Na,SO,.10H,O

(d) Na,SO₄.8H,O

A solution is prepared by dissolving 1.25 mol of an unknown substance in 1000 g of pure water, it is possible to find out whether this solute is an electrolyte or a nonelectrolyte by measuring

- (a) pH of the solution.
- (b) the boiling point of the solution.
- (c) the mass of the solution.
- (d) the molal concentration of the solution.

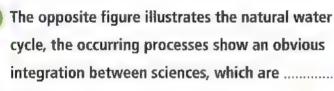


Which of the following ions produces gas bubbles on adding hydrochloric acid to its solid salt?

(a) Zn²⁺

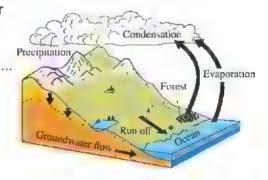
(b) SO₄²⁻

(c) CI





- (b) biology, chemistry and geology.
- (c) pharmacy, astronomy and chemistry.
- (d) agriculture, environment and mathematics.



Ethane gas reacts with oxygen according to the equation:

$$2C_2H_{6(g)} + 7O_{2(g)} \xrightarrow{\Delta} 4CO_{2(g)} + 6H_2O_{(v)}$$

What is the volume of CO₂ gas (at STP) which is produced when 4 L of ethane gas react with excess of oxygen gas?

(a) 2 L

b)3L

(c)4L

(d) 8 L



10				answers
(10)	Choose	two	correct	answers

Which of the following represents an empirical formula and also a molecular formula at the same time?

- (d) C₃H_A
- (b) C4H6
- C6H12O6
- (d) C₁₂H₂₂O₁₁
- e C2H4O2



Chloroethene C₂H₃Cl reacts with oxygen according to the equation:

$$2 \text{C}_2 \text{H}_3 \text{Cl}_{(\text{g})} + 5 \text{O}_{2(\text{g})} \longrightarrow 4 \text{CO}_{2(\text{g})} + 2 \text{H}_2 \text{O}_{(\text{v})} + 2 \text{HCl}_{(\text{g})}$$

Calculate the number of H,O molecules produced from the reaction of 10 mol of C2H2Cl with excess of oxygen gas.



How can the reaction of a concentrated solution of NaOH with 1 M (NH₄)₂SO₄ solution be indicated? Write the balanced symbolic equation including the physical states of





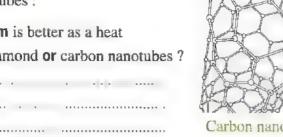
the reactants and products.

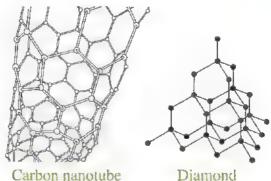


13 The opposite figures show

the molecular structure of diamond and carbon nanotubes:

(1) Which of them is better as a heat conductor, diamond or carbon nanotubes?





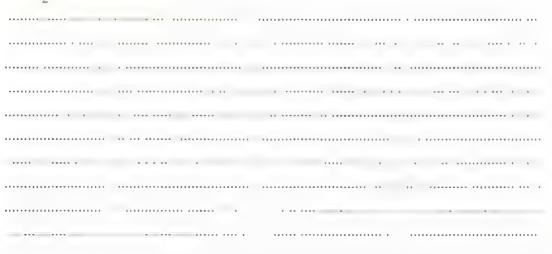
(2) Which is harder, carbon nanotubes or steel? Why?



14 According to the reaction shown by the equation:

$$2SO_{2(g)} + O_{2(g)} \xrightarrow{\Delta} 2SO_{3(g)}$$

What is the limiting reactant of the reaction upon mixing 1.5 mol of O2 with 2.5 mol of SO, ?





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a sample of magne	sium its mass	is 2.4 g with excess	of oxygen gas.	,
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****	****	+ 8+*++++ 11 +	,	11 110000
Given that the mol	ar mass of K ₃	PO ₄ compound equa	als 212 g/mol	
,.			,	11 1100000
* *************************************		* ** ** ******	* *************************************	
111		****** ***************		
				,,,,
				,,,,
				,,,,
C skeulyte the free	ing point of			
Calculate the free	zing point of	I m ammonium sul	phate aqueous solution	
	zing point of		phate aqueous solution	
	••• ,			444-11
,	••• ,		, ,	444-11







Choose the correct answer for the questions (







The opposite table shows the classification of some compounds. Which of the following represents the two groups (A) and (B) more accurately ?

Choices	(A)	(B)
<u>a</u>	Weak acids	Weak bases
(b)	Strong acids	Weak bases
0	Strong acids	Strong bases
(1)	Weak acids	Strong bases

(A)	(B)
HClO ₄	LiOH
H ₂ SO ₄	NaOH
HI	кон
HBr	Ca(OH) ₂
HCl	$Sr(OH)_2$
HNO ₃	Ba(OH) ₂

The chemical compound whose molecular molar mass equals its empirical molar mass

- (a) $C_A H_a$

- \bigcirc N₂H₄ \bigcirc K₂O₅ \bigcirc V₂O₅

An unknown liquid, its molar mass equals 70 g/mol and its density is 1.2 g/mL if you know that each 2 mL of this liquid give an average of 23 drops. What is the number of molecules of this liquid in one drop (where $\mathbf{N}_{\mathbf{A}}$ is Avogadro's number) ?

- (1.2) N_A $(1.2)^2 N_A$ $(1.2)^2 N_A$ $(1.2)^2 N_A$
- \bigcirc 1.2 N_A

Cosmology is a branch of astronomy that involves the origin and evolution of the universe.

What are the sciences which combine with cosmology?

- () Chemistry, geology and biology.
- (b) Mathematics, geology and biology.
- () Physics, astronomy and mathematics.
- (d) Chemistry, physics and mathematics.

1.24 g of the element P are found in 2.2 g of



- (a) $P_A S_a$
- (b) P,S,
- C PS,
- (d) P2S4



According to the reaction : $2AI_{(s)} + 6NaOH_{(aq)} \longrightarrow 2Na_3AIO_{3 (aq)} + 3H_{2(g)}$ What is the volume of the evolved hydrogen gas (at STP) when 27 g of aluminum [AI = 27] react with excess of sodium hydroxide ?

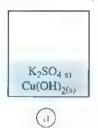
(a) 22.4 L

(b) 44.8 L

(c) 67.2 L

(d) 33.6 L

What is the figure which represents the heterogeneous mixture of $KOH_{(aq)}$ solution and $CuSO_{4(aq)}$ solution ?



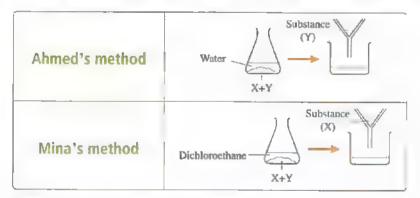
K[†]_(aq)
SO²⁻_{3(aq)}
Cu²⁺_(aq)
OH_(aq)

K[†]_(aq)
SO²_{4(aq)}
Cu(OH)_{2(s)}

Cu²⁺_(aq)
OH_(aq)
-K₂SO_{4(s)}

A mixture composed of an ionic compound (X) and an organic compound (Y),

Ahmed and Mina suggested two different methods to separate them.



Which of these methods is correct?

Choices	Ahmed's method	Mina's method
a	✓	1
Ъ	✓	×
0	Х	1
d	×	×

The acidic solution whose concentration is 0.01 M and pH = 2 is probably

(a) H₂CO₃

(b) HNO,

© CH,COOH

d H₃PO₄

) (Choose two correct answers:
7	The two substances which can be used to change pH value of the soil are
(a) calcium chloride.
(b) calcium hydroxide.
(sodium nitrate.
(① potassium sulphate.
(e) ammonium nitrate.
_	
	2 mark
1	Balance the following equation:
	$H_3PO_3 \longrightarrow H_3PO_4 + PH_3$
	1 mari
9	Suggest a safe therapy for cancer which can avoid the harms of the chemotherapy
ć	and the radiotherapy.
,	
	1 mar
	Calculate the molal concentration of an aqueous solution of glucose
((its molar mass is 180 g/mol) and its mass percentage concentration is 10%
,	
_	1 mar



of potassium bromide salt.	E 100	
Calculate the mass of the saturated aqueous solution	(O ^E H 3(0)1/atolox 3) Atlpipe (P ^E H 30) Atlpipe (
of potassium bromide (at 50°C) when the mass of	70 70	
the solute in it equals 120 g	ම 60 50	
	출 40 물 30	
	20	
	0	50 60 70 80 9
		nbetatre (C)

		7 1/1///
		,

solutions (A) and (B) having the same volume and molality: (1) Suggest a symbol for each of the two ions (X) and (Y).	olution (A)	CI X Solut
(2) What is the symbol of the solution with the higher	boiling point?	
	*** **********************************	
An aqueous solution contains a spoonful of sugar and	another spoonful	of table salt
Can the salt be separated from the sugar by filtratio	n ~ Why ~	
· ·····		



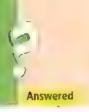
The reaction of zinc metal with hydrochloric acid is represented by the following hypothetical equation:

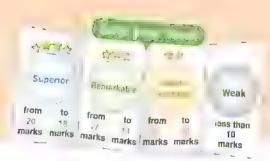
$$M_{(s)} + 2HX_{(aq)} \longrightarrow MX_{2(aq)} + H_{2(g)}$$

Suggest a hypothetical equation to represent the concept of Arrhenius base in the light of the previous reaction.



Exam model 19





for decorreansocion tregledons 9 marks In the opposite figure: 70 cm 65 cm What is the approximate value of the reading (X)? 668 mm (1) 67.5 cm ○ 680 mm 68.2 cm What does happen on mixing two equal volumes of 0.2 M K2CO3 solution with 0.2 M Na, PO, solution? (a) No precipitate is formed. (b) A precipitate of K, PO, is formed. © A precipitate of Na2CO3 is formed. (d) Precipitates of K₃PO₄ and Na₂CO₃ are formed. The conjugate base of water is (a) O²-(b) OH ©H,O+ (d) H₂O₂ Which of the following is chemically correct? Concentration of acid Strength of acid Choices pΗ (a) 2 0.01 M Strong (b) Weak 1 0.01 M (0) 3 M 5.5 Strong (b) Weak -0.53 M

The following solutions are equal in concentration, which of them is alkaline?

a MgCl₂

 \bigcirc K_2CO_3

© NaNO₃

(1) $(NH_4)_2SO_4$

The value which is not followed by a measuring unit is

(a) the molar mass.

(b) the nano shell diameter.

c the molal concentration.

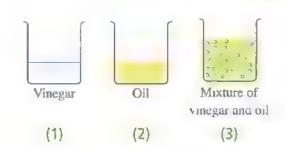
(d) pH



On mixing the components of the beakers

(1) and (2), the mixture (3) is formed as in the opposite figures.

Which of the following expresses the formed mixture and its components?



Choices	(1)	(2)	(3)
a	The solute	The solvent	A solution
h	The dispersed phase	The dispersion medium	A solution
©	The solute	The solvent	A colloid
(d)	The dispersed phase	The dispersion medium	A colloid

A sample of potassium chlorate KCIO, was heated in an open test tube, so it decomposed according to the equation:

$$2KClO_{3(s)} \xrightarrow{\Delta} 2KCl_{(s)} + 3O_{2(g)}$$

What is the percentage of the lost substance of potassium chlorate at the end of the reaction? [K = 39, Ci = 35.5, O = 16]

d) 30%

(1) 12%

(b) 28%

c) 39%

The mixture of silt in water is

- (a) a heterogeneous colloidal mixture.
- (b) a homogeneous suspension mixture.
- (c) a solution whose contents can not be separated by filtration.
- (d) a suspension mixture whose contents can be separated by filtration.

Choose two correct answers:

In the reaction: $CaCO_{3(s)} + 2HNO_{3(aq)} \longrightarrow Ca(NO_3)_{2(aq)} + H_2O_{(l)} + CO_{2(g)}$

0.08 mol of nitric acid is added to 0.05 mol of calcium carbonate.

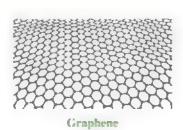
Which of the following is correct after the end of the reaction?

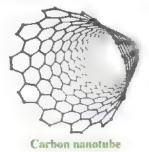
- (d) 0.05 mol of CO₂ is produced.
- (b) 0.08 mol of Ca(NO₃), is produced.
- © 0.04 mol of H₂O is produced.
- d 0.01 mol of CaCO, remains unreacted.
- (e) 0.03 mol of HNO, remains unreacted.

2 marks

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- 4		
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		٧.
	- 4	

The following figures show the structure of graphene film which can be converted into single-walled carbon nanotubes and Bucky ball:







(1) Compare between the rings forming each of graphene and Bucky ball "in terms of: Number of carbon atoms of each ring".

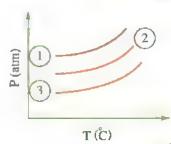
(2) Mention another difference between carbon nanotube and Bucky ball "other than the geometrical shape of carbon rings".



The mass of one drop of ethyl alcohol ($C_2H_5OH = 46 \text{ g/mol}$) is $2.3 \times 10^{-3} \text{ g}$ Calculate the number of the molecules of the alcohol in this one drop.

1 mark

The opposite graphical figure represents
the vapour pressure curves for two
pure liquids (A) and (B), in addition to
the solution results from mixing them (C).
If the liquid (A) is more volatile than the liquid (B).
Relate each curve to one of the letters (A), (B) and (C)



1 mark

Write the chemical equations that represent the dissol	lution of each of the following
substances:	
(1) Na ₂ SO _{4(s)} (strong electrolyte).	
(2) CH ₄ N ₂ O _(s) (nonelectrolyte).	

, , , , , , , , , , , ,	
(3) HBrO _(aq) (weak electrolyte).	
,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	
	1 mark
Coloubate the moles was of the same and an durant	
Calculate the molar mass of the compound produced f	
potassium element with selenium element which lies belo	
in the modern periodic table.	[K = 39, Se = 79]
, , , , , , , , , , , , , , , , , , , ,	***************************************
. , , , , , , , , , , , , , , , , , , ,	1
	I mark
Calculate the percentage of the practical yield,	
when 5 g of ethanol C ₂ H ₅ OH react with excess of potassi	ium permanganate K MnO
to form 4.24 g of acetic acid CH ₃ COOH according to the	7
,	
$3C_2H_5OH + 4KMnO_4 \longrightarrow 3CH_3COOH + 4I$	
	$\{C = 12, H = 1, O = 16\}$
,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	
······································	
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0	



ó	
,.	

(I) An unknown compound contains 24.2% carbon, 4% hydrogen and the rest is chlorine.

What is the molecular formula of this compound?

Given that its molar mass is 148.5 g/mol				$\{C = 12, H = 1, Cl = 35.5\}$		
	** ++++					
	4**************************************			,		
		** * **				
		** **			' '	
	*** ******					
				***********	**	
•			11		. ,, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	
			** ***********		*****	

Exam model 20



Guiding model of Ministry of Education 2019

Answered

Choose the correct answer for the questions (11): (







(a) 1 M sodium carbonate.

(b) 2 M sodium carbonate.

© 1 M iron (III) chloride.

(d) 2 M iron (III) chloride.



(a) Avogadro's number.

 $\bigcirc \frac{1}{2}$ Avogadro's number.

(c) 2 × Avogadro's number.

 \bigcirc Avogadro's number.

On dissolving 55.5 g of calcium chloride CaCl, in water to form a solution its volume = 0.5 L, the concentration of this solution equals [Ca = 40, Cl = 35.5]

- (a) I M
- (b) 0.5 M
- (c) 2 M
- (d) 1.5 M

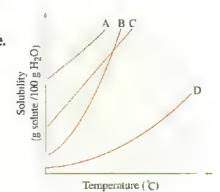
An experiment was carried out to find the molecular formula of an unknown compound which contains three elements (A), (B) and (C), it was found that the mass percentage of the element (A) is 40% and that of the element (B) is 12% What is the molecular formula of this compound, knowing that it is also the empirical formula?

[A = 40, B = 12, C = 16]

- (a) ABC,
- (b) A₂BC
- (c) AB₂C

 A_2B_2C

The opposite graph represents the relation between the solubility of some substances and the temperature. Which of these substances its solubility increases the most by increasing the temperature of the solvent?

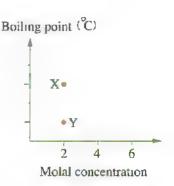




In the opposite graphical figure, if the solutions (X) and (Y) have the same molal concentration.

Which of the following pairs of solutions identifies the two solutions (X) and (Y) respectively?

- (a) Sodium chloride solution / Glucose solution.
- (b) Sodium chloride solution / Aluminum nitrate solution.
- (c) Potassium carbonate solution / Aluminum nitrate solution.
- (d) Potassium carbonate solution / Glucose solution.





From the following radicals:

CH₃COO⁻

 SO_4^{2-}

Na^{*}

NH'

Deduce the chemical formula of the salt, which dissolves in water forming a solution with pH value higher than 7

Arrange the following acids ascendingly according to their number of basicity:

H₃BO₃ / HCN / H₂SO₃



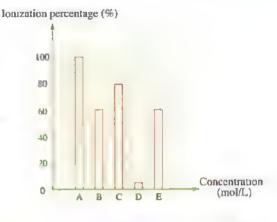
Deduce the conjugate acid and the base according to Bronsted - Lowry theory in the following equation : $CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+$

In the opposite graph.

Which of the illustrated compounds

(A, B, C, D, or E) represents the ionization of

an organic acid in water? Why?



Calculate the number of moles of iron (111) oxide he 103 produced from heating 456 g of iron (II) sulphate FeSO4 according to the equation : [Fe = 56, S = 32, O = 16]

 $2\text{FeSO}_A \xrightarrow{\Delta} \text{Fe}_2\text{O}_3 + \text{SO}_2 + \text{SO}_3$

The opposite graph represents the relation between the volume of hydrogen gas which evolves from the reaction of a limited amount of magnesium with excess of hydrochloric acid by time.

Deduce the time of consumption of half the amount of magnesium.

Wolume of H2 gas (mL) 20 Time (s)

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Answered

	 Choose the correct answer for the following questions: 				
	What is the number of the atoms in 1 n	aol of methanol CH3C	OH ?		
	a 6 atoms	ⓑ 6.2×10^{23} ator			
	© 12×10^{23} atoms	(d) 3.6×10^{24} ator	ns		
0	Ammonia gas reacts with oxygen gas a	ccording to the follow	ing unbalanced		
	equation: $NH_3 + O_2 \longrightarrow NO_2 + H_2O_3$)			
}	What is the number of moles of oxygen	in the balanced equa	tion?		
	(a) 1 mol (b) 3 mol	© 4 mol	d 7 mol		
(Heating iron pyrite ore FeS_2 (roasting)	is represented by the	following unbalanced		
	equation : $FeS_2 + O_2 \longrightarrow SO_2 + Fe_2O_2$)3			
	What are the coefficients of the reactar	nts and the products re	espectively?		
	(a) 4, 2, 8, 7 (b) 2, 4, 7, 8	© 2, 11, 7, 8	d 4, 11, 8, 2		
(1)	Doctors advise taking vitamin C (C_6H_8	O ₆) to avoid catching	cold.		
	What is the number of moles of vitamin C in 528 g sample of it ? C				
	(a) 2 mol (b) 3 mol	© 4 mol	(d) 5 mol		
(3)	Which of the following turns the colour	of litmus indicator in	to blue ?		
	a Vinegar.	(b) Baking soda so	olution.		
1	© Orange juice.	d Soft drink.			
•	Acids are the main cause of the corrosi	on of the teeth ename	Ι,		
	so calcium monophosphate $Ca(H_2PO_4)$	which is found in the	e teeth enamel is		
	a(an)				
	a basic substance.	(b) amphoteric sul	bstance.		
	© acidic substance.	d neutral substar	ice.		
	Which of the following acids does not form acidic salts ?				
	(a) Phosphoric acid.	(b) Carbonic acid.			
	© Hydrochloric acid.	(d) Sulphuric acid	4		

Four beakers, each of them contains
500 mL of water, and the amount of
sugar present in each of them is

Beaker (1)	Beaker (2)	Beaker (3)	Beaker (4)
150 g	250 g	450 g	0.5 g

different as shown in the opposite table:









What is the number of the beaker which contains a saturated solution?

(1)

(b) (2)

(c) (3)

(d) (4)

Aluminum reacts with hydrochloric acid according to the equation :

$$2Al + 6HCl \longrightarrow Al_2Cl_6 + 3H_2$$

What is the mass of hydrogen produced from the reaction of 25 g of aluminum with excess of hydrochloric acid? [At = 27, H = 1]

(a) 0.41 g

(b) 1.2 g

(c) 1.8 g

(d) 2.8 g

The following reaction was carried out using 5 mol of each reactant:

 $2KMnO_4 + 5Hg_2Cl_2 + 16HCl \longrightarrow 10HgCl_2 + 2MnCl_2 + 2KCl + 8H_2O$ What is the limiting reactant of this reaction ?

(a) KMnO,

(b) HCI

© H₂O

(d) Hg,Cl,

In the opposite equation : $HF + H_2O \longrightarrow H_3O^+ + F^-$ Which of the following is correct ?

- (a) H₂O represents the base, HF represents the conjugate acid.
- (b) H₂O represents the acid, HF represents the conjugate base.
- (c) HF represents the acid, F represents the conjugate base.
- \bigcirc HF represents the base, H_3O^+ represents the conjugate acid.





An ionic compound is composed of 29.08% of sodium, 40.56% of sulphur and 30.36% of oxygen.

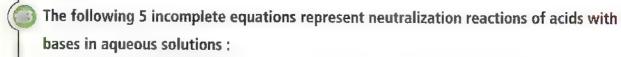
What is the formula of sulphur ion in this compound?

 $INa = 23 \cdot S = 32 \cdot O = 161$

(a)
$$S_2O_3^{2-}$$

$$\odot$$
 S₂O₅²

$$(] S_2O_6^2$$



$$(3)$$
 H₃PO₄ + Ba(OH)₂ \longrightarrow

The ionic equation : $H^+ + OH^- \longrightarrow H_2O$ represents

- (a) Reaction (1) only.
- (h) Reactions (1), (4) and (5).
- © Reactions (2) and (3) only.
- (d) Reaction (4) only.



(a)
$$3H_{(aq)}^+ + Al(OH)_{3(s)} \longrightarrow Al_{(aq)}^{3+} + 3H_2O_{(s)}$$

(b)
$$3HNO_{3(aq)} + Al(OH)_{3(s)} \longrightarrow Al(NO_3)_{3(aq)} + 3H_2O_{(l)}$$

$$\bigcirc$$
 HNO_{3(aq)} + OH⁻_(aq) \longrightarrow NO_{3(aq)} + H₂O₍₁₎

$$(1) H_{(aq)}^+ + OH_{(aq)}^- \longrightarrow H_2O_{(\ell)}$$

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Guiding model of Ministry of Education 2021

Answered

4	of a substance (A) decrease ility of substance (A) in wa	-		
What is the va	lue of its solubility at 60°C	: ?		
a 15 g / 200 g	5	(b) 5 g/	200 g	
© 5 g/100 g		d 10 g	/100 g	
pH value of th	e solution which results fro	om the diss	olution of potas	ssium acetate in
water	-1			
increases.	(b) equals 2	decre	eases.	equals 7
A case of coro	nary artery blockage can b	e treated b	y using	
a bucky balls	•	(b) carbo	on nanotubes.	
© nanorobots		d nano	shell.	
The opposite t	able shows the diameter			Dank, alaka
of the particle	s of some mixtures in		Mixture	Particle's diameter (nm)
nanometers.			(A)	1200
Which of these	e mixtures its particles can	be	(B)	900
distinguished	by naked eye ?		(C)	0.5
(C).	(b) (D).		(D)	0.25
© (A).	(d) (B).			
The mass of 1	molecule of methane CH ₄	gas in gran	ns equals	$C = 12 \cdot 11 = 3$
(a) 2.65 × 10 ²³	3	b 2.65	× 10 ⁻²³	
	© 26.5×10^{-23}			
When 78 g of	potassium combine with 16	g of oxyge	en by heating, a	compound is

© K2O

(b) K₂O₂

a KO₂

(d) KO

,	4	h	h	
á	ľ		3	١
٦	٩		Ņ)
		d	ń	ì

	ns acquire green colour upon the addition of some drops o				
bromothymol blue to the	_				
(a) KNO ₃	(b) CH ₃ COONa				
© Na ₂ SO ₄	(d) NaCl				
Iron reacts with sulphur	Iron reacts with sulphur as follows : $Fe_{(s)} + S_{(s)} \longrightarrow FeS_{(s)}$				
If 0.5 mol of sulphur had	reacted with iron, and a mass of sulphur remained.				
What is the reacting mas	s of iron ?				
② 28 g	(b) 112 g				
© 20 g	(d) 58 g				
The acid which yields mo	re than one type of salts is				
(a) HNO ₃	⊕ CH ₃ COOH				
© HCIO ₄	$\bigcirc C_2H_2O_4$				
In the illustrated electric	al circuit :				
Which of the following se	olutions when being				
placed in the beaker yiel	ds the dimmest light				
of the light bulb?	n				
a NaOH _(aq)					
(b) NH ₄ OH _(aq)					
© KOH(20)					
(d) KNO _{3(aq)}					
	qually concentrated solutions, its freezing point is the leas				
(a) NaCl _(aq)	(b) C ₆ H ₁₂ O _{6(aq)}				
© Na ₂ CO _{3(aq)}	(d) AlCl _{3(aq)}				
The components of the w	rireless nano devices are connected with wires				
a whose particles dimen	sions are 3 m, 2 nm, 1 nm				
(b) whose three dimension	as are in the nanoscale.				
(c) which have one nano o	timension.				

d whose particles dimensions are 3 nm, 2 m, 1 nm



4 substances (A), (B), (C) and (D), the dimension of each of them is as follows:

(A): 12 nm

(B): 50×10^{-5} m

(C): 80×10^{-9} m

(D): 1×10^{-9} m

Which of these previous substances does not exhibit unique properties of the nanomaterials?

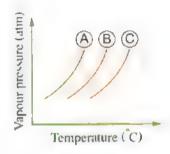
(b) (B).

(1) (C).



The opposite graphical figure represents the relation between the vapour pressure and the temperature of several solutions:

Substance	Number of moles	Volume of solution	
Na ₂ CO ₃	0.3	1 L	
NaCl	0.4	1 L	
KNO ₃	0.5	1 L	



According to the data in this table,

- (a) substance (A) represents NaCl, and substance (B) represents KNO₃
- (b) substance (A) represents KNO3, and substance (B) represents NaCl
- substance (A) represents Na2CO3, and substance (B) represents KNO3
- (d) substance (A) represents NaCl, and substance (B) represents Na2CO3

Booklet model

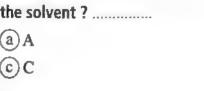
The guiding model of the ministry a

	· Choose the correct answer for the questions ()
1	Which of the following solutions has higher boiling point?
1	(a) 1 M sodium carbonate.
	(b) 2 M sodium carbonate.
	© 1 M iron (III) chloride.
	d 2 M iron (III) chloride.
2	Number of atoms in half a mole of formaldehyde HCHO equals
1	a Avogadro's number.

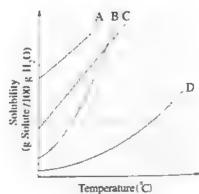
- $\bigcirc \frac{1}{2}$ Avogadro's number. © 2 × Avogadro's number.
- $\frac{1}{4}$ Avogadro's number.
- 3 On dissolving 55.5 g of calcium chloride $CaCl_2$ in water to form a solution its volume = 0.5 L , the concentration of this solution equals $(C_0 = 40), C_1 = 35.5$ (d) 1.5 M © 2 M (b) 0.5 M (a) 1 M
- An experiment was carried out to find the molecular formula of an unknown compound which contains three elements (A), (B) and (C), it was found that the mass percentage of the element (A) is 40% and that of the element (B) $\,$ is 12%, what is the molecular formula of this compound, Knowing that it is also [A = 40 , B = 12 , C = 16]the empirical formula?.....

(b) A,BC (a) ABC₃ (d)A,B,C(c) AB, C

The opposite graph represents the relation between the solubility of some substances and the temperature, which of these substances its solubility increases with a higher extent by increasing the temperature of the solvent?.....







the opposite graph, if the solut same molal concentration, 50 1 and the solution () g sodium chloride solution E sodium chlorade solution Eponssium carbonate solution / alternment mirate solution Promissium carbonate solution glad con all a Mough the following radicals: CH₃COOT pecuce the chemical formula of the salt, which dissolves in water forming a solution with pH value higher than 7 7 So Salut in 15 11. and the contraction of the second of the second January or ing might to be wing by fortuna of wing and in the Arrange the following acids ascendingly according to their number of basicity H₃BO₃/HCN/H₃SO₃ HC1/44,50, 2436, Deduce the conjugate acid and the base according to Bronsted - Lowry theory in the following equation : $CH_3COOH + H_2O = CH_3COO^- + H_3O^-$ - Secondations In the opposite graph Which of the illustrated Solubiles percentage 5. compounds (A, B, C, D, or E) represents the ionization of an organic acid in water? Why? Compound Diasons a Gibaro mark a los, That

refet condiction Fernanter



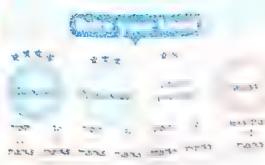
(III) Calculate the number of moles of iron (III) oxide Fe₂O₃ produced from bea of iron (II) sulphate FeSO₄ according to the equation : $2\text{FeSO}_4 \xrightarrow{\Delta} \text{Fe}_2\text{O}_3 + \text{SO}_2 + \text{SO}_3$ 304 - 2E Stuy mas Ed Ja. 4.55 Signi 2(56#32+64) -2 1.5:12.13.

half amount of magnessium Consumed when He gas opland As in

The opposite graph represents the relation between the volume of hydrogen gas which is evolved from the reaction of a limited amount of magnesium with excess of hydrochloric acid by time, deduce the time of consumption of half the amount of magnesium.

Volume of H₂ gas (mL) all amount of manager mis Consumed when the solume of hillogen gas become constent (30ml) at 5 min





a character of the control of the questions



Which of the following measuring relations is incorrect?

what is the mass percentage of hydrogen in chlorous acid HClO,?

what is the number of nitrogen atoms in 240 g of ammonium nitrate?

(a)
$$2 \times 10^{23}$$

(b)
$$6.02 \times 10^{23}$$
 (c) 1.81×10^{24}

©
$$1.81 \times 10^{24}$$

M = 1 , 6 '= 30 5 , C = 10

What is the total number of moles of H⁺ which are found in 2.5 L phosphoric acid its concentration is 0.7 M?...

a 0.233 mol

S Which of the following solutions has higher boiling point? ...

Which of the following colloids is formed from dispersion of liquid in solid?

(a) Hair gel, cheese and butter.

b Milk, hair gel and blood.

© Aerosol, jelly and mayonnaise.

d Mayonnaise, hair gel and cheese.

35.5 mL aqueous solution contains 22.5 g of sucrose (its molar mass = 342 g/mol) 15 61 What is the molar concentration of this solution?......

№ 0.0657 M

(b)
$$1.85 \times 10^{-3} \,\mathrm{M}$$
 (c) $1.85 \,\mathrm{M}$

ĺ		2
•		
	0	

10 g of hydrogen gas react with excess of oxygen gas according to the equation :

$$2H_{2(g)} + O_{2(g)} \longrightarrow 2H_2O_{(v)}$$

What is the reacted volume of oxygen gas (at STP) and the mass of the produced water vapour in this reaction?

Choices	Reacted volume of O ₂	Mass of H ₂ O
(a)	2.5 L	5 g
b	5 L	5 g
C	56 L	90 g
(d)	80 L	120 g

Zmalo	· Jones
277-	1 4 /b
15	
7 = 10	-75-04
2 677 4	554

Each of the following acids when dissolves in water, it can yield more than one proton, CH2 Cool

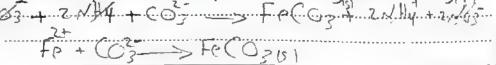
What does happen when a small crystal of the solute substance is put in its supersaturated solution?

- (a) The crystal dissolves in the solution only.
- (b) The solution becomes saturated only.
- (c) The molecules of the solute will be collected around the crystal only.
- (d) (b), (c) together.

11 "Carbon is found in the form of graphite and diamond", Mention three other forms in which carbon can be found. Single aton _ Carbon neno tubes _> Bucky ball

Calculate the molar mass of calcium phosphate compound. [Ca = 40, P = 31, O = 46]Ca/PO4) = (3x4a)+2(31+64) 120 + 190 = 312 9 ml Mol

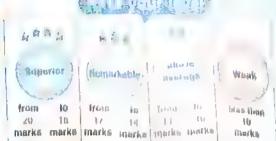
Complete the following equation, and rewrite it in the form of an ionic equation: Fe(NO₃)_{2(aq)} + (NH₄)₂CO_{3(aq)} - Fe(O)+2MH4NO_{3e1} Fe+2NO₃+2NH4+CO₃ Fe(O₃+2MH4NO_{3e1})



	What is the type of the aqueous solution of sodium nitrate salt					
9	(acidic, basic or neutral) ? Explain.					
	(acidic, basic or neutral)? Explain.					
	(HAO3) and Grand Justine 19.					
	THE LOW					
(15	In this reaction: $NH_{3(g)} + H_2O_{(f)} = NH_{4(aq)}^+ + OH_{(aq)}^-$					
	What does each of the following represent in the light of Lewis concept of acids					
	and bases:					
	(1) Ammonia gas.					
	(1) Ammonia gas.					
	(2) Water. Lewis aud as it scott in the					
	Lewis alid as It					
	and the second second					
(10	Sulphuric acid is added to barium hydroxide until the reaction is completed.					
4	. It which represents this feethor, the					
,	the physical state of barium hydroxide only in this reaction, then explain which					
	· · · · · · · · · · · · · · · · · · ·					
	is larger in number: the ions which are present in the beginning of the reaction or the ions which are					
	present at the end of the reaction?					
	present at the end of the reaction? $Ba(OH)_{2} + H_{2}SO_{4} \rightarrow B_{1}SO_{4} \rightarrow B_{2}SO_{4}$					
	The greater number of jons at the old server					
4	The greater number of jons at the occurrence and a realistic					
	Le assistantial and a second an					
1	Calculate the percentage of the actual yield of zinc sulphate, if its calculated					
17	Calculate the percentage of the actual yields					
	(1 with all mass = 1.358 g and its actual inter-					
3	go actual xially actual nois					
and the second	de actual yills					
i i	1,001					
	1.145 84.39.96					
	1.145 × 120 = 84.39 %					
6						

(3)						

Booklet model



		1	The state of the s
Choose the	correct answer for the qu	uestions 🕕 ; 🕦 .	mart.
In bucky bal	l, every carbon atom is at	ttached to	other carbon atoms.
(a) 1	(b) 2	© 3	(d) 4
Each of the	following is a solution, ex	ccept	
1	gs with sulphur powder.		chloride gas in water.
© iodine in	benzene.	d silver in m	
Two closed	vessels contain chlorine g	as at the same cond	itions of temperature and
	if the first vessel whose		
what is the	number of moles in the se	econd vessel whose	volume = 2.33 L ? .
a 0.452 m	ol (b) 3.74 mol	© 12 mol	(d) 20,3 mol
Which of the	e following aqueous solut	tions has lower freez	ing point ?
(N		(b) 0.1 m MnS	
© 0.1 m Na	aF	@ 0.1 m CH ₃	ОН
In which of	these choices H ₂ PO ₄ acts	s as an acid ?	
a H ₃ PO ₄ +	$-H_2O \longrightarrow H_3O^+ + H_2P$	O ₄	
(b) H ₂ PO ₄ +	$+ H_2O \longrightarrow H_3O^+ + HPO$	O_4^{2-}	
200	$-OH^{-} \longrightarrow H_{3}PO_{4} + O^{2}$		
d An ion c	an't act as an acid in any c	hemical reaction.	
All of the fo	llowing are colloids, exce	pt	
a air in wh	ipped egg whites.	(b) air in cotto	on candy.
© ground r	naize powder in water.	d oxygen in	atmospheric air.

(knowing that water density = 1 kg/L)

(a) 1000 mL of the solvent.

Molal solution contains 1 mol of the solute in

(b) 1000 g of the solution.

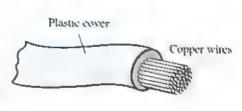
1 L of water.

d 22.4 L of the solution.

Which of the following choices represents the proper use for the measuring tool?

Choices	Measuring tool	Used in
(a)	(1)	Transferring 20 mL of an alkali to carry out a titration.
Ь	(2)	Collecting 75 mL of the gas produced from a thermal decomposition reaction
0		Adding 1 mL of an acid to calcium carbonate.
d		Adding 15.6 mL of an acid to carry out a titration.

- on dissolving NH₄CiO₄ acid in water, the formed solution is
 - (a) acidic.
- (b) neutral.
- (c) basic.
- m What is the meaning of that nitric acid is a strong acid?
 - (a) It dissolves in water and H⁺ concentration in the solution equals OH⁻ concentration.
 - (b) It does not ionize in water on dissolving in it.
 - c It ionizes completely in water into H+, NO; ions.
 - (d) It is neutralized by a strong base only.
- 11 The opposite figure represents a section in a flexible copper cable, it easily bends with the bends of the plastic pipes inside walls and ceilings, is it useful to replace copper which is used in the manufacture of cable wires with any of the following? Explain your answer.

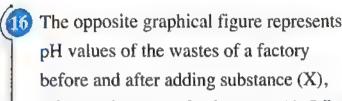


(1) Copper nano wires. NO, Bec, The how diress of Capper in Clease by de croasing volume of its particle; to nanoscole and it con't be bend

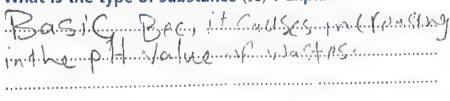
(2) Single - wall carbon nano tubes. Jes, as the ability of Carbon hand tubes to Conduct ple ltricity is larger than Copper

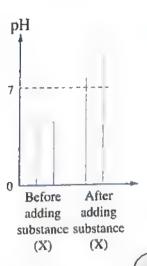


	xygen in 0.52 g of sodium bio	[Na = 23, H = 1, C = 12, C]
<i>.</i>	123+1+12+46))
	(23+1+12+46)	-5 VK
	015.7	territoria de la companya della companya della companya de la companya della comp
? <u>-</u> ,	0.52×48297	9.9-m
	84	
*****************************	*** **** ******** *** *** ************	
The opposite graph shov		80 70
of four different substan		H ₂ O
which of these substan	ces its solubility is :	Solubility 100 20 20 20 20 20 20 20 20 20 20 20 20 2
(1) As high as possible a	t 10°C	Solubility (8 solute /100g H ₂ O) (90 90 90 90 90 90 90 90 90 90 90 90 90 9
(D)	医乳蛋白蛋白蛋白蛋白蛋白蛋白蛋白蛋白 医水流性医静中腺炎 电电影电影中枢 化分离 电电路 医甲甲烯	90 10
(2) As low as possible at	90°C	0 10 20 30 40 50 60 70 80 Temperature (°C)
(D)		-
		by filling in the spaces in
Compare between hydr	ogen chloride gas and glucos	
Compare between hydr the following table : Points of comparison	ogen chloride gas and glucos Hydrogen chloride gas	Glucose
Compare between hydr	Hydrogen chloride gas	Glucose
Compare between hydr the following table : Points of comparison	ogen chloride gas and glucos Hydrogen chloride gas	Glucose
Compare between hydrethe following table: Points of comparison (1) Solubility in water	Hydrogen chloride gas	Glucose
Compare between hydrethe following table: Points of comparison (1) Solubility in water (2) Ionization in water	Hydrogen chloride gas Soluble Complete jantedion	Glucose
Compare between hydrethe following table: Points of comparison (1) Solubility in water (2) Ionization in water Choose, with explanation	Hydrogen chloride gas	Glucose Soluble
Compare between hydrethe following table: Points of comparison (1) Solubility in water (2) Ionization in water Choose, with explanation	Hydrogen chloride gas	Glucose
Compare between hydrethe following table: Points of comparison (1) Solubility in water (2) Ionization in water Choose, with explanation at test tube which contain PO ₄	Hydrogen chloride gas Hydrogen chloride gas	Glucose
Compare between hydrethe following table: Points of comparison (1) Solubility in water (2) Ionization in water Choose, with explanation at test tube which contain PO ₄	Hydrogen chloride gas Hydrogen chloride gas	Glucose



What is the type of substance (X)? Explain.





(117) Rewrite the following word equation as a balanced symbolic equation:

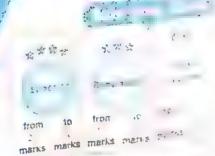
Magnesium nitrate + Potassium phosphate

Magnesium phosphate + Potassium nitrate $aMg(NO_3)_2 + bK_3 POH CMg_3 (POH)_2 + bKNO_3$

 $Mg \Rightarrow a = 3C$ $N \Rightarrow 2a = d$ $C = \frac{1}{3}$ $C = \frac$

3 Mg (NO3)2 +2K3 PO4 -> Mg3 (PO4)2+6KNO3

Booklet model 4



Choose the correct answer for the questions

The screen of the mobile phone is covered with nano liquid to form a thin even its surface to protect it from scratching and breaking, what is the type of the material used in manufacture of this nano liquid ?

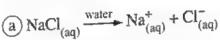
a Colloidal substance.

b One-dimensional nano substance.

© Suspension substance.

(d) Two-dimensional nano substance.

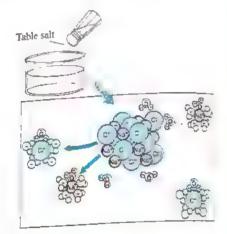
Which of the following equations represents the process of dissolving the table salt in water which is illustrated in the figure ?



(b)
$$NaCl_{(s)} \xrightarrow{water} Na_{(s)}^+ + Cl_{(s)}^-$$

$$\bigcirc$$
 NaCl_(s) $\xrightarrow{\text{water}}$ Na⁺_(aq) + Cl⁻_(aq)

 $\textcircled{d} \text{NaCl}_{(aq)} \xrightarrow{\text{water}} \text{Na}_{(s)}^+ + \text{Cl}_{(g)}^-$



3 The ionic equation which represents the reaction of sodium hydroxide solution with hydrochloric acid does not contain each of \bigcirc Na⁺, OH⁻ \bigcirc \bigcirc H⁺, Cl⁻

a Na+, Cl-

(b) H⁺ , OH[−]

In the following reaction: $6Li_{(s)} + N_{2(g)} \longrightarrow 2Li_3N_{(s)}$ What is the number of moles of lithium required to react with excess of nitrogen gas to produce 0.6 mol of lithium nitride ?

(a) 0.2 mol

(b) 0.3 mol

(c) 0.4 mol

(d) 1.8 moi

S Each of the following is among the properties of lactic acid, except that it

(a) is found in yaughurt.

(b) is an organic acid.

© reacts with sodium to form salt and water.

(d) is a weak acid.

0	The	following	compounds	formulas
---	-----	-----------	-----------	----------

KNO3, Pb(NO3)2, Fe(NO3)3

indicate	that	the	nitrate	group	is	*****
----------	------	-----	---------	-------	----	-------

a monovalent only.

b divalent only.

c) trivalent only.

d mono, di, and trivalent.

Which of the following examples is an application of Avogadro's law?........

- (a) When 3 balloons contain equal numbers of H₂, O₂ and Cl₂ molecules, their volumes will be equal at the same temperature and pressure.
- b The balloon which contains H₂ gas, its volume increases by increasing temperature at constant pressure.
- The volume of a balloon decreases with decreasing the number of moles of Ar gas in it at constant temperature and pressure.
- d The volume of a piston which contains neon decreases by increasing the pressure at constant temperature.
- 8 In the opposite table
 Water that contains a little amount of acetone, its boiling point is

Substance	Boiling point
Acetone	56°C
water	100°C

(a) 56°C

(b) 78°C

© 100°C

(d) 104°C

extro	i mole)
-------	---------

- Which of the following choices represents dissolving table sugar (its molar mass = 342 g/mol) in water and dissolving table salt (its molar mass = 58.5 g/mol) in water ?
 - (a) Both form liquid in solid solutions.
 - b Both are electrolytes.
 - © Freezing point of the salt solution is lower than the freezing point of sugar solution at the same concentration.
 - d On adding X mass of each to the same volume of water, sugar solution concentration will be higher than that of salt solution.
 - On neutralizing acetic acid with sodium hydroxide solution, is formed.
 - (a) alkaline solution.

(b) acidic solution.

© neutral solution.

d gaseous solution.



7	The opposite figures (X), (Y) represent two sections in two measuring tools:	(e	27	Lulu
	• Tool (X): is used in measuring a definite volume of an acid accurately.		26 -	in min
	• Tool (Y): is used in estimating the increase in the volume of water on dipping a piece of iron in it, what is the name of each tool? What is the volume in each of them? **Butches** **Column** **C	of the meas	ured liquic	(Y)
12	In the opposite figure which represents the solubility curve of potassium nitrate in water, on stirring 75 g of potassium nitrate in 100 g of water at 100°C, no precipitate is formed and when the solution is cooled to 30°C a precipitate appears. What is the type of solution (unsaturated / saturated / supersaturated)? Explain your answer and calculate the precipitated mass of potassium nitrate after cooling to 30°C approximatel Super Sat Water and Cooling to 30°C approximatel Super Sat Water after cooling to 30°C approximatel Sat Water after cooling to 30°C	y. Solution		C
(13)	Calculate the mass percentage of carbon in oxalic acide $COOH$	2	(C = 12.0)	= 16 . H =
A de la constitución de la const	Percenter: 24 x100 = 26.6	7.7.	**********	



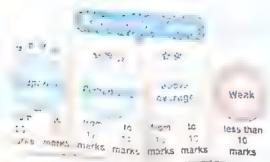
Experiment	Observation
1) On falling a beam of light on the mixture	The light is scattered
2) On leaving the mixture for some mine after sha	Mercury precipitates in oil
3) On pouring the mixture in a funnel contains a filte	r paper Mercury is separated from oil
epending on these observations, recognize the	type of this mixture, with explaining.
Is it a solution? up for Six is in the year of morning in it is it. 1 19 at the will be year of the will as it is a second to the second to	
s it a colloid ?	***************************************
161 (61616) 03 (5100 Falt)	mioraris Carit opsplan
wid filteration.	
4	
s it a suspension?	
1PS, as Susperson Scatt	
Helifilato of April 18 12	
sita suspension? 1125, as Suspension? 4606461 as be of April as Kins	
Helifilato of April 18 12	
Africation (April at sex	and con Ecparation by
strate by a symbolic equation only the defin	aition of an acid in the light of
istrate by a symbolic equation only the defin	nition of an acid in the light of pens in water which contains
istrate by a symbolic equation only the definition of the change that happened drops of methyl orange indicator by adding	nition of an acid in the light of pens in water which contains g the acid to it?
strate by a symbolic equation only the defin	nition of an acid in the light of pens in water which contains g the acid to it?
ustrate by a symbolic equation only the definition of the change that happened drops of methyl orange indicator by adding	nition of an acid in the light of pens in water which contains g the acid to it?



Among the famo	1 . ()		A T 1 %	
• Iron (II) oxide,	+60	 Calcium c 	oxide. (a)	
(D) Illustrate by s	symbolic equations o	nly a similarity be	ween the two c	ompounds.
1. 1. 6. A. A. H.	Chamb Facto	A Haram		
5 10 6 . Ja 6 . W 3	He true my and	L' Allan	1000 and 111 and 100 a	
11 ' 11 11 Ch	11 2	1111-61	roic Odida	madle ac
(3) Milhu is iron (1	H) oxide described as	G. G. and and and	a (ti) a 116	Cium oxida
(a) willy is from (t	ti oxide described as	a base and not an	aikan, wille ca	icium oxide
is described a	s a base and an alkali	?	1	101
	base as it	divide of the M	Q. pallal	.(
	Rode Zillon	and alkali	as it dis	5,01\hrs
	alas.	and alkali	as it dis	Soldes . La
Calculate the mo	olar concentration of	a solution of the ta	ble salt its volu	ime = 1.5 L
Calculate the mo	plar concentration of a	a solution of the ta	able salt its volu	ıme = <u>1.5</u> L
Calculate the mo	plar concentration of a	a solution of the ta	able salt its volu	ıme = <u>1.5</u> L
Calculate the mo	olar concentration of	a solution of the ta	able salt its volu	ıme = <u>1.5</u> L
Calculate the mo	olar concentration of a sodium chloride w	a solution of the ta there its molar ma moiss molormass 26:325 = 6	sble salt its volu ss = 58.5 g/mol	ime = 1.5 L
Calculate the mo	olar concentration of a sodium chloride w	a solution of the ta	sble salt its volu ss = 58.5 g/mol	ime = 1.5 L

II

Booklet model



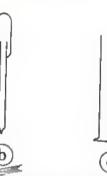
Choose the correct answer for the questions (1): (1)





Which of the following tools shown in figures can be used to transfer the highly







You have four solutions of equal concentrations, which of them conducts electric current by a higher degree ?

(b) HBr

(c) HCN

d H,SO,

Nitric acid is similar to acetic acid in that both are acids.

(a) organic

(b) mineral

(c) strong

(d) monobasic

What is the empirical formula of the compound that contains 85.6% carbon and 14.4% hydrogen ?

(a) CH

© CH₃

 $\{C = 12, H = 1\}$ (d) CH

S Which of the following is not a strong base?.....

a Ca(OH),

(b) KOH

© NH,

(d) LiOH

6 What is the mass of solute in a solution of ammonium chloride, its volume is 📆 🗝 🕬 🕬 256 mL and its concentration is 0.9 M ? [N = 14, H = 1, Ci = 35.5]

(a) 12.3 g

(b) 16.3 g

(c) 175 g

(d) 215 g

What is the number of types of salts that phosphoric acid can form ? (14, PO4)

(a) 1

In the following equation:

 $C_6H_5NH_{2(aq)} + H_2O_{(f)} = C_6H_5NH_{3(aq)}^+ + OH_{(aq)}^-$

Reactants and products can be classified as follows:

(a) acid + base ==== acid + base.

(b) acid + base ==== base + acid.

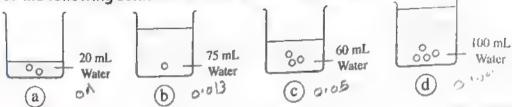
 $\stackrel{\text{C}}{\longrightarrow}$ base + acid \Longrightarrow acid + base.

(d) base + acid base + acid.



- The following acids: $(H_3PO_4/HCI/H_2SO_3)$ are arranged from weaker to stronger as follows:
 - (a) HCl < H₃PO₄ < H₂SO₃
 - © H₂SO₃ < H₂PO₄ < HCl

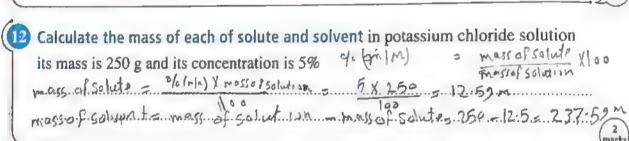
- (b) $HCI < H_2SO_3 < H_3PO_4$
- (d) H₃PO₄ < H₂SO₃ < HC|
- Which of the following solutions is more saturated?.......



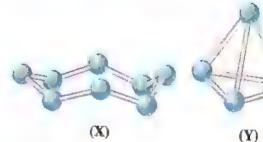
The opposite figure shows a nanorobot that Dr. Magdi Yacoub dreams to use in his field to carry out operations without surgery.

Suggest an importance for the nanorobot.

Yamaica blood Lots from blood apsceles, when



the structure of phosphorus and sulphur vapours (with no particular order) if you know that the gram atomic mass of phosphorus is 31 g/mol and that of sulphur is 32 g/mol :



- (1) Which figure represents the structure of phosphorus vapour molecule?
- (2) Calculate the molar mass of the vapour of the two elements.

 S8 = 8 x 32 = 256 gm/m.

 P4 = 4x31 = 124 gm/m.



Complete the following table with what is suitable of the following substances:

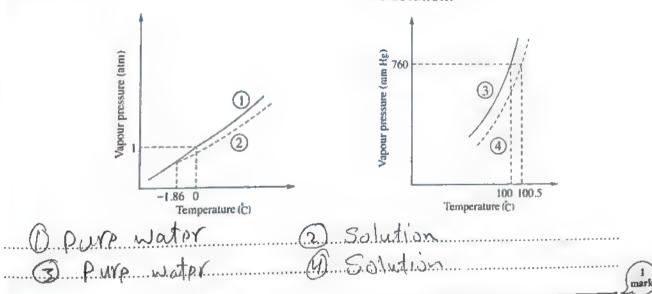
Gas	or the	ronowing su
Cours Cours	Laquid	Solid
Nickel chrome alloy	Atmospheric air	Sea water

Types of solution	Physical state of solute	Physical state of solvent	Everet
(1) Gaseous solution	Jack',		Example
(2) Liquid solution	044	···ling uld	Smwale
3) Solid solution	5011	(2.11)	mickalChyomo a

In the light of your knowledge about the relation between the vapour pressure and each of boiling and freezing points of each of pure water and the solution, replace the numbers shown on the following figures with what suits each of them from the terms:

· Pure water.





The following ions can form several salts:

Na⁺

 NH_4^+

Cl

CO₃²⁻

Conclude the chemical formula of the salt that dissolves in water forming:

(1) A solution its pH equals 7

(2) A solution its pH is less than 7

(3) A solution its pH is more than 7

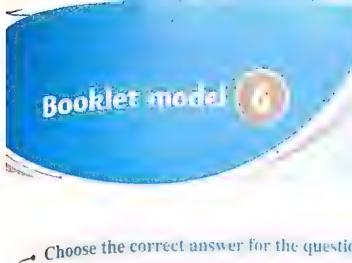
MAGI.)

(NAZP3





Calculate the mass percentage of hydrogen (H = 1) in magnesium beam cante
compound, its molar mass is 146 g/mol
Mg(HCO3)2 211
146.9.
mass of H = mass of 141 in I male strong 1360.0%





Choose the correct answer for the questions





Which of the following expresses a quantitative measurement?

- a Aluminum bar is longer than copper bar.
- (b) The first solution is more concentrated than the second solution.
- (c) The colour of the first solution is blue.
- d The temperature of the second solution is 60°C

Which of the following is an application of Avogadro's postulate?

- a) oxygen atom is 16 times heavier than hydrogen atom.
- b 1 cm³ of each of Ar. O₂. NH₃ gases contains the same number of molecules at 80k and 1 atm.
- (c) Volume of hydrogen gas increases by increasing its number of moles at constant temperature and pressure.
- (d) A mole of any gas such as CH₄ contains 22.4 L (at STP).

What is the number of moles of hydrogen sulphide in 49.7 g sample of it?

[S = 32, H = 1]

- (a) 0.686 mol
- (b) 1.46 mol
- (c) 83.8 mol
- (d) 24.7 mol

4) Which of the following acids is a strong acid?

- (a) HF
- (b) KOH
- © HClO₄
- (d) HClO

 $\frac{5}{2}$ On dissolving 16.4 g of HF in water, a solution its volume is 2×10^2 mL and its concentration is is formed.



- (a) 0.82 M
- (b) 0.16 M
- © 0.08 M
- (d) 4.1 M

6 What is the type of the compound which dissolves in water and does not dissolve in benzene?

a polar only.

b nonpolar only.

(c) polar or nonpolar.

d polar or ionic.





- (a) cobalt (II) chloride in water
- b aqueous solution of cobalt (II) chloride in kerosene
- © milk
- d copper sulphate in water



Choices	Length	Width	Height
a	1.2×10^{-11} m	$200 \times 10^{-10} \text{ m}$	$320 \times 10^{-12} \text{ m}$
b	$21 \times 10^{-10} \mathrm{m}$	0.18×10^{-5} m	$17.9 \times 10^{-9} \text{ m}$
©	$130 \times 10^{-7} \text{ m}$	49 × 10 ⁻⁷ m	$68 \times 10^{-6} \mathrm{m}$
d	$17 \times 10^{-8} \text{ m}$	$83 \times 10^{-4} \mathrm{m}$	96×10^{-3} m

- If the formula of antimony oxide is Sb_2O_3 and that of sodium phosphate is $Na_3PO_{4'}$ what is the formula of antimony phosphate ?
 - a SbPO₄

(b) Sb,PO,

© Sb₂(PO₄)₃

- (d) Sb₃PO₄
- 20 mL of carbon monoxide gas combust in excess of oxygen according to the equation:

$$2CO_{(g)} + O_{2(g)} \xrightarrow{\Delta} 2CO_{2(g)}$$

What is the produced volume of carbon dioxide gas (at STP) ?

a 20 mL

(b) 40 mL

© 60 mL

- (d) 80 mL
- A chemical reaction is expressed by the opposite symbolic equation:

$$aA + bB \longrightarrow cC + dD$$

What is the number of possible values of the value? with explanation.

Only one value, as the vatio of coffections in the



The following figures express.	and in of the pure crystals of one of the salts:
	The state of the s
(1) (2)	(3) (4)
Mention the name of a salt can be prep	ared by this method. With explanation.
INACITY DO MILLE WAS THE	base my toda infurence
Cartille work and white	of a feel to began for a lot of grown 3 ded ion
*** ******* ******* *******************	1 mark
In the chemical reaction illustrated by the	a following equation :
In the cheffical reaction mustrated by the	$CH_3COO_{(aq)}^- + NH_{4(aq)}^+$
CH ₃ COOH _(aq) + NH _{3(g)}	(aq) 4(aq)
	evious equation with the appropriate term of
the following:	
conjugate base ac	cid conjugate acid base
aci) baca	Conjugate base to conjugate acid
	Jmark
0.16	0.0149 8
In the reaction: $Ca_3(PO_4)_2 + 3H_2$	$_2$ SO ₄ \longrightarrow 3CaSO ₄ + 2H ₃ PO ₄
co (DO) was added to 4.4 g	of H ₂ SO ₄ ,
illustrate by chemical calculations the	limiting reactant for this reaction.
	$Ca_3(rO_4)_2 = 3to g mor tage 3$
Co3 (PO4), >3CaSO4	3 H2 SO4 -> 3 CaSO4
Janel Smell	J. mall
male 3 3 male	3×98 -> 3 male
310 -> 3 mole	294 -> 3 male
510	4.4.
129	2 - 3X4.4 5 0.1944
	7 3X4,4 5 0 1044 294
? 129 X3 1,248 mo)	USS no of Casay males
	C C as Oy males
	AZSOUIS Imming



the percentage of rheni	um Re in it is 63.6%		10 10 10
	mss. and a war for a for		
		4	
mass.	*	** ** * 34\$	
roles	15000 15000 15000	7 11 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	
Routia	3.1	41	
**********	Re Cl3	,	
	49 s in nanosecond unit?		
What is the value of 9.	***************************************		

.495 = 9.49 X18	***************************************		nthalein indica
1495 = 9.49 X18 If you have 1 mL of eac	n\$	acid and phenolph	nthalein indica
If you have 1 mL of each How to differentiate be	h of colourless hydrochloric	acid and phenolph	
If you have 1 mL of each How to differentiate be * Experiment:	h of colourless hydrochloric	acid and phenolph	
If you have 1 mL of each How to differentiate be * Experiment:	h of colourless hydrochloric	acid and phenolphical experiment?	(aOH)

300 det min :

Water molecules |



Choose the correct answer. Quantitative measureme a) includes a numerical y b) doesn't include a numerical d) is achieved through present the correct answer.	nt /alue and a measu erical value		marks,
a) includes a numerical y b) doesn't include a numerical	nt /alue and a measu erical value		
(a) includes a numerical y (b) doesn't include a numerical	alue and a measu	ring unit.	
Common traitilling	Crical value	ring unit.	
(d) is achieved through	Transfer A STITUTE		
Construction through he	action and	(c) always includes	a comparison
All the chemical form	actical experimen	its.	,
All the chemical formulase except	s of compounds s	shown in the following	na table ave
except		3313411	A rapid ate Cottec
(a)	(b)		
Aluminum sulphate	<u>(b)</u>	C	(d)
	Calcium nitrate	Iron (III) bromide	Potassium sulphid
$Al_2(SO_4)_3$	Ca(NO ₃) ₂	Fe ₃ Br	K ₂ S
configuration is (2, 8, 7) produced from combining	g the atoms of th	ne two elements (X)	(V) 2
(a) 67 g/mol (b)	99 g/mol	© 103 g/mol	d 134 g/mol
Which of the following re	epresents a pair	of conjugate acid and	d b 3
(a) H ₃ PO ₄ , PO ₄ ³ - (b)	H_PO7, PO3-	© H.PO HPO2	Judse /
In which of the following	(2) 4 · · 4	G 163 04, 111 04	H ₂ PO ₄ , HP
In which of the following is higher?	, compounds the	mass percentage of	hydrogen
_			I = 1, $Ct = 35.5$, $O = 16$
(a) HCI 36.5	H ₂ O	© H ₂ SO ₄	(d) H2S34 5.3
A STATE OF THE STA	iagrams express	es the solution produ	د د ced from dissolvin
Which of the following d	3. amin cybic32(The second second	
Which of the following d sugar in water ?		production of the state of the	
			1

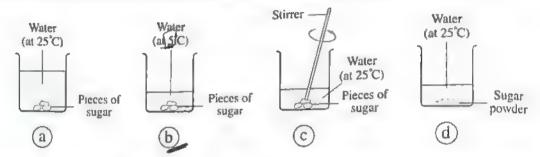
(b)

(a)

(1)



- Which of the following statements is correct?
 - (a) The aqueous solution of magnesium oxide its pH value is less than 7
 - b) The aqueous solution of sulphur trioxide its pH value is greater than /
 - Calcium oxide reacts with nitric acid forming salt and water.
 - d Carbon dioxide reacts with hydrochloric acid forming salt and water.
- In the experiment illustrated by the following figures, 2 g of sugar are used with different volumes of water at different temperatures, what is the state in which the dissolution process of solute in the solvent takes longer time?



- $C_6H_{12}O_6 \longrightarrow 2C_2H_5OH + 2CO_2$ According to the reaction : on adding 100 g of yeast to 1 mol of $C_6H_{12}O_6$, 32.3 g of C_2H_5OH are formed, what is the percentage of the actual yield of C_2H_5OH ? [C = 12, H = 1, O = 16]
 - (a) 35.1%

(b) 17.5%

© 100%

- (d) 32.3%
- What is the ionic equation which represents the formation of calcium carbonate salt, which is insoluble in water from the reaction of ${\rm CaCl_2}$, ${\rm Na_2CO_3}$ solutions ?

(a)
$$Ca_{(aq)}^{2+} + CO_{3(aq)}^{2-} \longrightarrow CaCO_{3(aq)}$$

(b)
$$Na_2CO_{3(aq)} + CaCl_{2(aq)} \longrightarrow 2Na_{(aq)}^+ + 2Cl_{(aq)}^- + CaCO_{3(s)}$$

$$Ca^{2+}_{(aq)} + CO^{2-}_{3(aq)} \longrightarrow CaCO_{3(s)}$$

(d)
$$Na_2CO_{3(aq)} + CaCl_{2(aq)} \longrightarrow 2NaCl_{(aq)} + Ca_{(s)}^{2+} + CO_{3(s)}^{2-}$$

Mhat is the difference between silver nano particles and silver particles which

The Mano Particles are measured in home Scale, while the Particles Seen by naked eyes measured in macko scale

1	Show he could be
4	Show by symbolic equations, which reacts with larger volume of hydrochloric acid.
	and of soundin carbonate or 1 mol of sodium bicarbonate?
	:/az Coz + 2146.leg. 2-1/2/+ 1
	to be the second of the second
:	Hati (6 + 110)
7	Hatice + 110/10 - 1100 cg: + 110, 100 cg: + 110, 10
Î	My Can wait with a service and their and
ſ	May Cay reach with sugar value and Add. Box to
	my was the contract of the
2	
A A	(murku)
	Calculate the molality of the solution produced from adding 0.25 mol of
	potassium bromide to 1.25 kg of water.
	Fre 100 4 20 m = 0 05 = 0 00 m .
ŧ	
7	
	murk)
	What does happen when each of the following is added to a heterogeneous mixture
	of water and benzene? With explanation.
7	I Oil.
	Cilly: dissolve in ser Ence not water as it is non for
	The state of the s
	Compound that six olver in non it ol ar included
9	
	2) Potassium hydroxide.
	it will dissolves an ateras it work Companie
	Lucy alias in Es as Salsont
	The state of the s
) mark
5	Calculate the mass of 37.8 L of methane gas (at STP). $C = 12.H = 11$
	min = (12+4) = 16
	Mass V mass - IXmm 77.941
	Mass => mass = V/mm = 37.8×16-279m
-	
	· ····································



Calculate the mass of phosphorus vapou	rs [P = 31] that conta	ins the	Same number of
molecules which are found in 4.23 g of sa	tohur vapours $1S = 3$	21.	
in In frastintons lapour on Pus	4/3/ = 121	1.50,00	1.46 4
mm frastinions lapour on Pys		, m. f. 16	(.S.
harof males = 4123	165 mais		
" March Wills I lake in the son	pros student		•
	A. B		**************************************
the same district hands from the	es scalle by the	1/22	1. 14. 18 9 r (2)
Thu same six			
The opposite graph represents the relati		B_1	<i>t. t</i>
the vapour pressure of (pure water and an	aqueous solution)	-	9 //
and the temperature,		ie i	
Write beside each term of the following			2
the appropriate number that represents	it		
(in the graph)			16. 110
(in the Stabil)		3	(3) (5) (7)
(in the graph)		3	Temperature (°C)
(1) 3 freezing point of solution 2	vapour pressure of solution	3	Temperature (°C) boiling point of solution
(1) 3 freezing point of solution 2. (2) 4. freezing point of pure water	vapour pressure of	6	boiling point of solution boiling point of
(1) 3 freezing point of solution 2. (2) 4. freezing point of pure water 4. Which is greater:	vapour pressure of solution vapour pressure of pure water	5	boiling point of solution boiling point of pure water
(1) 3 freezing point of solution (2) 4. freezing point of pure water Which is greater: the difference between the boiling points	vapour pressure of solution vapour pressure of pure water	5	boiling point of solution boiling point of pure water
(1) 3 freezing point of solution 2. (2) 4. freezing point of pure water 4. Which is greater: the difference between the boiling points between the fragging points.	vapour pressure of solution vapour pressure of pure water of pure water and the	soluti	boiling point of solution boiling point of pure water
(1) 3 freezing point of solution 2. (2) 4. freezing point of pure water 4. Which is greater: the difference between the boiling points between the fragging points.	vapour pressure of solution vapour pressure of pure water of pure water and the	soluti	boiling point of solution boiling point of pure water
(1) 3 freezing point of solution 2. (2) 4. freezing point of pure water 4. Which is greater: the difference between the boiling points between the fragging points.	vapour pressure of solution vapour pressure of pure water of pure water and the	soluti	boiling point of solution boiling point of pure water
(1) [3] freezing point of solution [2] (2) [4]. freezing point of pure water [4]. [4]. Which is greater: the difference between the boiling points.	vapour pressure of solution vapour pressure of pure water of pure water and the	soluti	boiling point of solution boiling point of pure water

Booklet model









Which of the following prefixes do not represent its true value?

$$\delta$$
 Kilo = 1000 units.

$$\sqrt{d}$$
 Nano = 10^{-9} of the unit.

On mixing 2 mol of the substance (A) with 1 mol of the substance (B) according to the hypothetical equation : $3A + B \longrightarrow C + D$ Then the limiting reactant will be , with explanation.

- (a) A. Because its molar mass is the smallest.
- DA Because all its moles are consumed in producing the least number of products moles.
- B Because the number of its moles is less than the number of moles of (A).
- (d) B Because 3 molecules of (A) react with 1 molecule of (B).

A sample of oxygen gas its mass is 32 g contains

[H = 1, O = 16]

- (a) 6.02 x 10²³ oxygen atoms. 3 c n/4
- (b) 1.204 × 10²⁴ oxygen molecules
- the same number of oxygen atoms found in 18 g of water, a
- (d) the same number of oxygen atoms found in 36 g of water.

Why is glucose soluble in water, while benzene is not, inspite of both being organic compounds ?

- (a) due to difference of their molar masses.
- (b) because glucose is an ionic compound, while benzene is a covalent compound.
- (c) because glucose is a strong electrolyte, while benzene is a weak electrolyte.
- d because glucose contains polar O H bonds, while benzene contains C, H only.

On measuring the boiling and freezing points of an aqueous solution of sodium chloride the readings of the two thermometers were

- (a) 98°C, -1.6°C
- (b) 100°C, 0°C
- © 102°C.-1.6°C
- (d) 102°C.0°C



On adding HX acid to water with stirring, there are two probabilities shown in the following figures:



the first probability

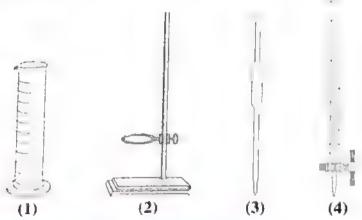


the second probability

HX acid acts in

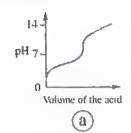
- white first probability as a weak acid and the second probability as a strong acid.
- the first probability as a strong acid and the second probability as a weak acid
- the two probabilities as a weak acid. (d) the two probabilites as a strong acid.
- One of the most famous sauces is prepared by whipping egg yolks, and during continuous whipping, oil is added drop by drop, then afterwards drops of vinegar are added, what is the classification of the mixture which composes this sauce?
 - Colloid (liquid in liquid).

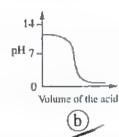
- (b) Colloid (liquid in solid).
- © Suspension (solid in liquid).
- (d) Solution (gas in liquid).
- Which of the following tools would be used in a titration process? and what is the missing tool?..

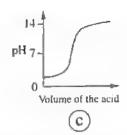


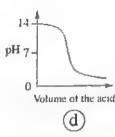
hoices	Used tool	Missing tool
(a)	(1),(2)	Glass beaker
(b)	(2),(3)	Analytical balance
(E)	(1),(4)	Round - bottom flask
(d)'	(2),(4)	Conical flask

Which of the following curves represents the titration of a weak base with a strong acid?









Which of the following equations represents correctly the reaction of sodium carbonate solution with sulphuric acid?

(a)
$$Na_2CO_{3(s)} + H_2SO_{4(aq)} \longrightarrow Na_2SO_{4(s)} + H_2O_{(l)} + CO_{2(g)}$$

ⓑ
$$CO_{3(aq)}^{2-}$$
 + $2H_{(aq)}^{+}$ → $H_2O_{(l)}$ + $CO_{2(g)}$

©
$$Na_{(s)}^+ + CO_{3(s)}^{2-} + H_2SO_{4(aq)} \longrightarrow Na_2SO_{4(aq)} + H_2O_{(l)} + CO_{2(g)}$$

(d)
$$CO_{3(s)}^{2-} + 2H_{(aq)}^{+} \longrightarrow H_2O_{(aq)} + CO_{2(g)}$$

"Science fiction is becoming by time and efforts touchable facts" Clarify the previous statement in the light of astronomers expectations regarding the use of carbon nano tubes.

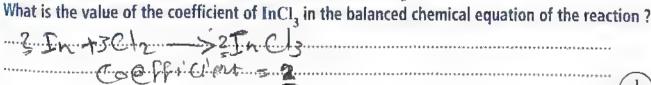
Carbon nano tubes are very hard and very light, which may use in making spaces hutters and elepators

Calculate the molality of the solution produced from dissolving 2.7 g of CH₃OH in

25 g of H₂O [C = 12, H = 1, O = 16]

molality _ horneles = 0.0844 = 3-3.75 m

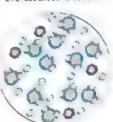
B Solid indium element reacts with chlorine to form InCl₃



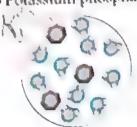


14 The following figures represent the solutions of three different compounds which are

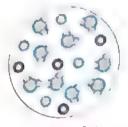
· Sodium chloride.



· Potassium phosphate.

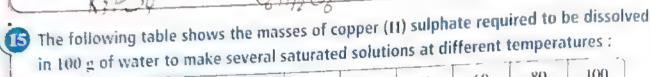


· Glacose.



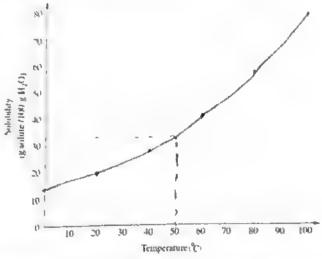
(1) Potaguanthaphali (2) Galu Case

(3) Sadium Chloride Write below each figure the chemical formula of the compound which represents it.



(00 g of water to make	0	20	40	60	80	100
Temperature (°C)	1.4	20	28	40	56	77
Solubility (g solute/100 g H ₂ O)	[4	20				

(1) Use the values shown in the previous table to draw the solubility curve of copper (II) sulphate.



(2) What is the maximum mass of copper (II) sulphate can be dissolved in 100 g of water at 50°C?

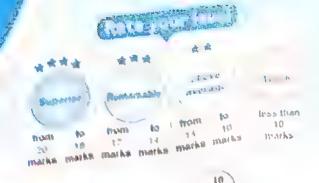
332349m

Complete the following equation: $H_2SO_{4(aq)} + H_2O_{(l)} \longrightarrow H_2SO_{4(aq)} + H_3O_{(aq)}^+$ and why water is classified in this process as a base?

work is baseasit accepts the HT Proton:

17	4 balloons are inflated with four different gases at the same conditions	
	of temperature and pressure, the mass of:	[H = 1]
	• Hydrogen gas in the first balloon was 0.02 g	[He = 4]
	• Helium gas in the second balloon was 0.04 g	[Ne = 20]
	 Neon gas in the third balloon was 0.2 g Oxygen gas in the fourth balloon was 0.32 g 	[() = 16]
	Arrange these balloons according to their volume, explain your answer with	
	chemical calculations.	
	The contract west	
	Ho your grad male	,,,,,,
	No 5 20 ord male	
	Ballons are equals in Volumes as they Cantains	.orolmoland
	according Avogdrus Pastulates they are equi	
		marka

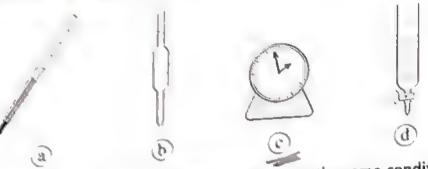
Booklet model 9



(marks

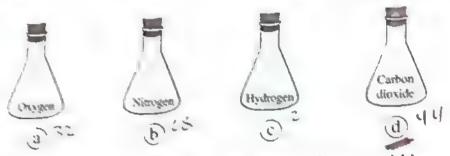


One of the students performed an experiment to measure the change in temperature on adding 25 mL of dilute hydrochloric acid to different volumes of sodium hydroxide solution, which of the following tools the student would not need during the performance of the experiment?



In front of you 4 similar flasks contain four different gases at the same conditions of pressure and temperature, which of these flasks its molar mass is larger?

[O = 10. N = 14. H = 1. C = 12]



Which of the following ions can not behave as a base and as an acid in different reactions?....

a H.POT

D CO:

CHCO;

(d) HSO,

What is the anion that exists in greater concentration in the solution which is produced from the reaction of 0.1 mol of H, AsO, acid with 0.1 mol of sodium hydroxide?

a HAsO;

(b) OH

CH, AsO,

Light 2 + 1631 Sodium sulphate salt is found in many crystalline forms. Which of the following sodium sulphate crystalline salts loses 43.2% of its mass on

3 N2,SO,H,O

© Na,SO,.6H,O

d) Na,SO₄.8H₂O

306

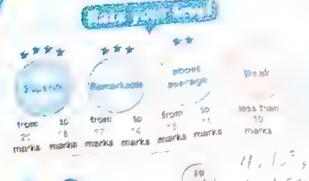
A solution is pro	epared by dissolving	1.25 mol of an unknown	substance in
1000 g of pure	water, which of the f	ollowing by measuring it	we can conclude that
the solute is an	electrolyte or nonel	ectrolyte ?	(
a Temperature	of water.	b Freezing point	of solution.
© Volume of so	olution.		ration of solution.
Which of the fo	llowing ions produce	s gas bubbles on adding	
solid salt ?		- 3as adobies on adding	nyarocinoric acia to its
a Cu ²⁺	ⓑ Fe ³⁺	© Al ³⁺	(d) CO_3^2
The opposite gr	aphical figure repres	ents the effect	
of temperature	on the activity of on	e of the human	Section Religion
digestive enzym	nes, this represents t	he integration	
between chemis	stry and		
a physics.		b biology.	20°C 70°C Temperature (°C)
© pharmacy.		d agriculture.	
Which of the fol	lowing represents a	n empirical formula and a	molecular formula in
the same time ?		r comparied formula and a	i niolecular formula in
a C ₅ H ₁₂		(b) C ₅ H ₁₀	
$\bigcirc C_4H_8$		$\bigcirc C_4H_{10}$	
Ethane gas react	ts with <mark>oxygen</mark> accor	ding to the equation :	2 mol ->4mol
		$\Delta \rightarrow 4CO_{2(g)} + 6H_2CO_{2(g)}$	2x27-4 -> 4x2
What is the volu	me of CO ₂ (at STP)	which is produced when	(3)
reacts with exce	ss of oxygen ?		7=8L
(a) 2 L	(b) 3 L	© 4 L	<u>@</u> 8 L
How can the rea	ction of	7 1	
be indicated 2 W	rite the balanced are	ed solution of NaOH with	1 M (NH ₄) ₂ SO ₄ solution
reactants and proc	fricts	mbolic equation including	g the physical states of
(NH4), 504,	12 Ma (7) -	> Na250419	+2/+20(2) +2N/13(g
We Can	indicate th	us by the e	Volving of ammon
	90151	with burgen	tomin line



12	The opposite two figures show the molecular structure of diamond and carbon nano tubes:
电电子 医乳	onductor, diamond or carbon care mites?
4	Carbon nano tube Diamond 2. Which is harder, carbon nano tubes
a Real Property	or steel? and why? The form is the content of the
The second second	
(B)	Chloroethene compound C_2H_2Cl reacts with oxygen according to the equation: $2C_2H_2Cl_g \div 5O_{\mathcal{F}_g} \longrightarrow 4CO_{\mathcal{F}_g} + 2H_2O_{(v)} + 2HCl_{(g)}$ Calculate the number of H_2O molecules produced from reaction of 10 mol of C_2H_3Cl
	with excess of oxygen gas-
The second second second	100 100 100 100 100 100 100 100 100 100
The same of the same of	= 6-5-4:014 molecules
14	Calculate the mass of magnesium oxide that can be obtained by reacting a sample of
	magnesium its mass is 2.4 g with excess of oxygen. [Mg = 24.0 = $\frac{2N}{3}$]
Name of Street, or other Persons and Perso	2 M3 -> 2 M35 Emale -> 2 mele
	7.4 X
	7- 80 x24 - 49 x

	ccording to the reaction shown by the equation :
	$2SO_2 + O_2 \longrightarrow 2SO_3$
	That is the limiting reactant on mixing 1.5 mol of O ₂ with 2.5 mol of SO ₂ ?
	2502 -> 2503 - C27 250g
	Zyelle se my Toxally . Such se man pit for so is in
	The standard of the standard o
	7 - 212:5 - 2 - 3 - 27 15 - 2 2 - 2 - 2 - 2 - 2 - 2 - 2 - 2 - 2
	Son amount consumed to whole Co sit one
	OF 503 males
	502 is intrescerclart.
	2
-	an a practical experiment to prepare 3 L of K ₃ PO ₄ solution with 0.2 M concentration iven that the molar mass of K ₃ PO ₄ compound equals 212 g/mol
	iven that the molar mass of K ₃ PO ₄ compound equals 212 g/mol
	iven that the molar mass of K3PO4 compound equals 212 g/mol Mo. moles = Malarity X Valurals Solution = 22 X 3 = 0.6
	iven that the molar mass of K3PO4 compound equals 212 g/mol no.moles = Malarity X Nolumber Solution = 12 X 3 = 0.6 mass = no.almales X reclaim mass = a.6 X 212 = 127-29 m and 12729m of K3 DO4 to 11 a Cuater out
	iven that the molar mass of K3PO4 compound equals 212 g/mol no moles = Malarity X No unlass solution = 12 X 3 = 0.6 mass = no of males X reclaim mass = a16 X 212 = 127-2 gm and 1272gm of K3 Day to 1 Lass of water one and 1272gm of K3 Day to 1 Lass of water one and in please dissolution (and the the solution
	iven that the molar mass of K3PO4 compound equals 212 g/mol no moles = Malarity X Nalurales Solution = 12 X 3 = 0.6 mass = no of males X molar mass = a16 X 212 = 127-2 gm and 1272gm of K3 Day to 1 La fueler mass styling of the field of solution (and the field of solution)
	iven that the molar mass of K3PO4 compound equals 212 g/mol Mormoles = Molarity X No une of solution = 12 X 3 = 0.6 mass = nor of males X reclaim mass = a16 X 212 = 127-29 m ald 12729 of K3 DO4 to 1 L of water cris sty water till 32.
	iven that the molar mass of K ₃ PO ₄ compound equals 212 g/mol No. moles = Molarity X Nolumer of Solution = 12 A 3 = 0.6 mass = no. of males X molar mass = a.6 X 212 = 127-2 g m ald 1272g m of K ₃ Doy to 1 L of voder or solution style water till 31.
	iven that the molar mass of K ₃ PO ₄ compound equals 212 g/mol Mormoles = Molarity X Nolumed Solution = 12 X 3 = 0.6 Mass = nord males X molar mass = a.6 X 212 = 127-29 m and 1272gm of K ₃ Doy to 1 L of wader one string water till 3 L alculate the depression in the freezing point of water, when an amount of ckel (II) nitrate salt is dissolved in it to form a solution, its molal concentration is 1 m,
	lan a practical experiment to prepare 3 L of K ₃ PO ₄ solution with 0.2 M concentration iven that the molar mass of K ₃ PO ₄ compound equals 212 g/mol Mo. moles — Molerity X Nolume of Solution = 22 X 3 = 0.6 mass = no. of males X molecuments = a.6 X 212 = 12.7 2 g m and 12.72g m of K ₃ Pour to 1 L of vader cross graph water the Solution (a.m.) Little the Solution alculate the depression in the freezing point of water, when an amount of ckel (II) nitrate salt is dissolved in it to form a solution, its molal concentration is 1 m, nowing that the molal freezing point depression constant of water is 1.86°C.kg/mol
	iven that the molar mass of K ₃ PO ₄ compound equals 212 g/mol Mol moles = Molarity X Nolumed Solution = 12 X 3 = 0.6 Mass = no. of males X molar mass = a.6 X 212 = 127-29 m and 1272gm of K ₃ Doy to 1 L of wader comb style water the Solution alculate the depression in the freezing point of water, when an amount of ckel (II) nitrate salt is dissolved in it to form a solution, its molal concentration is 1 m,

Booklet model (10



I hoose the correct answer for the questions (1): (1)

Uranium is supposed to exist in earth's crust in ratio of 4 g for each 1 ton of earth's crust, what is the mass of uranium exist in 1.5 mg of earth's crust?

a, 6 harrigians.

6,6 microgram. 6,6 milligram.

d, 6 × 10 5 gram.

What does happen on mixing two equal volumes of 0.2 M K₂CO₃ solution with 0.2 M Na PO solution ?

a two precipitate is former.

b, A precipitate of K, PO4 is formed.

To, A precipitate of Na₂CO₁ is formed . (d) A precipitate of K₂PO₂. Na₂CO₂ is formed.

The conjugate base of water is

(2) (g2-

(c) H2O+

(d) H,O,

Which of the following choices is chemically correct?

Choices	Strength of acid	Concentration of acid	pH
Car	(South)	0.01 M	<u>(2)</u>
(b)	Weak	0.01 M	1
(c,	Strong	3 M	5.5
(d)	Weak	3 M	-0.5

The following solutions are equal in concentration, Which of them is alkaline?

(a) 1.1(1)

To K POAC & C NaClO

(d) NH4NO3

Phosphorus P_4 can be prepared from the following reaction:

	2Ca (PO ₄)2	+ 6SiO ₂ +	10C	6CaSiO ₃	+	10CO + P ₄
Molar mass	16m/g (01)?	O) g/mal	12 g/mol			
Masses present in reaction medium	3370 g	1795 g 4198.	650 g 8-46			

What is the limiting reactant for this reaction?

(a) C

(b) Ca₃(PO₄)₂

(c) SiO,

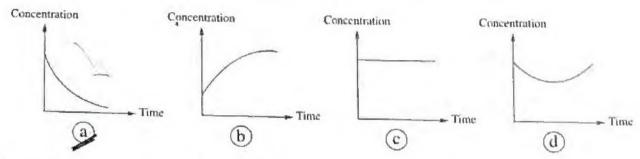
 $(\mathbf{d}) P_{\mathbf{d}}$

- Which of the following values is not followed by a measuring unit?
 - a Molar mass.

(b) Nano shell diameter.

© Molal concentration.

- (d) pH
- A mixture of ethanol (its boiling point is 78°C) and water (its boiling point is 100°C) can be separated by fractional distillation method, which of the following graphs expresses the concentration of the mixture by time?



A sample of potassium chlorate KCIO₃ was heated in an open test tube, so it decomposed according to the equation:

 $245, \text{min} 2\text{KClO}_{3(s)} \xrightarrow{\Delta} 2\text{KCl}_{(s)} + 30_{2(g)}$

96 x 100=

What is the percentage of the lost substance of potassium chlorate at the end of the reaction?

[K = 39, C1 = 35.5, C0 = 16]

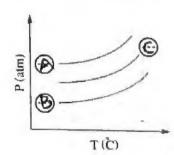
- (a) 12%
- (b) 28%
- © 39%
- (d) 30%

The mixture of mud in water is

(page 198)

- a heterogeneous colloidal mixture.
- b a homogeneous suspension mixture.
- © a solution whose contents can not be separated by filtration.
- d a suspension mixture whose contents can be separated by filtration.
- The opposite graph represents the vapour pressure curves for two pure liquids (A) and (B) and the solution resulted from mixing them (C).

If the liquid (A) is more volatile than the liquid (B), Indicate each curve by one of the letters (A), (B) or (C).



ma



12 The following three figures show the structure of graphene film which can be converted into single-walled carbon nano tubes and Bucky ball: Bucky ball Carbon nano tube (1) Compare between the rings forming each of graphene and Bucky ball "in terms of: number of carbon atoms of each ring". in graphene Consists of G. Corhonators but Ky bal Consist out to anybandon (2) Mention another difference between carbon nano tube and Bucky ball "other than the geometrical shape of carbon rings". Nano tubes 2 dimensional bucky ball is 7 diesement 13 The blood of adult person contains about 2.64×10^{13} red blood cells, the mass of iron in it is 2.9 g, Calculate the number of iron atoms in each red blood cell. 264×163 > 2.9 2.9 51.0.28 Xb-10 Stam..... No, of mules in each Cell = 1.09811510 5 1.966 X1512

porafatoms = na of moles x Avagodrana

1.066 x1512 x 6 w2 x 1,23 = 1.18x 1012 atom



1. K Se	$(K = 39, 3\alpha =$
1 2	
1/25e [2139	17972 153
Calculate the percentage of the practical yield,	
when 5 g of ethanol C2H5OH react with excess of potassium pen	manganate KMnO ₄
to form 4.24 g of acetic acid CH2COOH according to the equation	
$3C_2H_5OH + 4KMnO_4 \longrightarrow 3CH_3COOH + 4MnO_2 +$	$4KOH + H_2O$
	$\{C = 12, H = 1, G =$
3C2+404->3C1-3CC	16H
3,50 Sa 2 3.11. 2. 3	
3(547 + 6 + 16) -> 3,113	117 + 4+32
133	*********************
138 6.529	May
of elactualyield = actual ylos	6.62

_	(000
Write the chemical equations that represent the formation of	- La
the following substances:	the solution of each
1) Na_SO _{4(s)} (strong electrolyte).	
- HA 504 -20 > 245 + 50	7 -
113.00 q	913)

2) CH,N,O, (nonelectrolyte).	
2) $CH_zN_2O_{(s)}$ (nonelectrolyte).	
2) $CH_2N_2O_{(s)}$ (nonelectrolyte). $CH_4M_2C_{(s)}$ $CH_4M_2C_{(s)}$ $CH_4M_2C_{(s)}$	***************************************
CHYM G 420> CHCW2O (99)	***********************



assum ma	16/0002	C. L			[C = 12 , H	
	±22	- ,	24.2		***************************************	
Y	· ofmales	The second second	24.2	4		
*************************		35.8	12			
	Ratio	2	2	12		
	pirical	CH;	2 C-1			*******
Ma.	of wass a	L. sassici	get so ()	2.4.2.4.3.	5.5) = 49.5	********